Appendix F.

Linkage Analysis

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Abbreviations and Acronyms[1]

ALU	aquatic life use
DA	drainage area
DO	dissolved oxygen
DMR	discharge monitoring report
EWH	exceptional warmwater habitat
HSTS	household sewage treatment systems
HU	hydrologic unit
HUC	hydrologic unit code
IBC	impaired biotic communities
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
LDC	load duration curve
NPDES	National Pollutant Discharge Elimination System
Ohio EPA	Ohio Environmental Protection Agency
OWTS	on-site wastewater treatment systems
RM	river mile
RU	recreational use
SJR	St. Joseph River
SJRW	St. Joseph River watershed
SJRWI	St. Joseph River Watershed Initiative
TMDL	total maximum daily load
TP	total phosphorus
TSS	total suspended solids
UT	unnamed tributary
WAU	watershed assessment unit
WWH	warmwater habitat

Units of Measure[2]

cfs	cubic foot per second
gpd	gallon per day
lb/d	pound per day
mgd	million gallons per day
mg/L	milligram per liter
µg/L	microgram per liter

[1] All abbreviations and acronyms in this appendix are defined above. They are not defined in the footnotes below each table or figure.
[2] All units of measure in this appendix are defined above. They are not defined in the footnotes below each table or figure.

F-1. Source Assessment Information Applicable to All Subwatersheds

This section presents general source assessment information, assumptions, and data gaps applicable to all subwatersheds in the St. Joseph River watershed (SJRW).

F-1.1 Facilities Covered by General NPDES Permits

Industrial, construction, and municipal separate storm sewer system (MS4) stormwater can transport deposited bacteria, nutrients, or sediments from impervious surfaces, through pipes or open channels, to streams. However, flow, concentration, and load data are not available for regulated stormwater sources. Regulated stormwater is assumed to contribute to aquatic life use (ALU) and recreational use (RU) impairments but is not considered to be significant sources.

F-1.2 Regulated Livestock Operations

The Indiana Department of Environmental Management (IDEM) prohibits concentrated animal feeding operations (CAFOs) or confined feeding operations (CFOs) from discharging untreated wastewater to surface streams; the Ohio Environmental Protection Agency (Ohio EPA) does the same for Concentrated Animal Feeding Facilities (CAFFs). Such wastewater may be land-applied to agricultural fields. The only information available for CAFOs and CFOs is location information and counts of livestock. CAFOs, CAFFs, and CFOs are not considered to be significant sources of bacteria, nutrients, or sediment.

F-1.3 Unregulated Livestock Operations

Runoff from hobby farms and unregulated livestock operations may contain bacteria, nutrients, and sediment. SJRWI (2008a) identified livestock, livestock access to streams, and manure runoff directly to streams during its windshield survey. No additional information about hobby farms and small livestock operations are available but such operations are present throughout each subwatershed. Since livestock may contribute bacteria, nutrient, and sediment loads, they are considered a cause of impairment.

F-1.4 On-Site Wastewater Treatment Systems

On-site wastewater treatment systems (OWTS) treat commercial and domestic wastewater. In Ohio, OWTS that only treat domestic wastewater are called household sewage treatment systems (HSTS). Malfunctioning or poorly sited on-lot OWTS and all off-site discharging OWTS may contribute bacteria, nutrients, and sediment loads to nearby surface streams. No off-site discharging HSTS are in the Ohio-portion of the impaired subwatersheds discussion in this appendix.

Load data are not available to assess the potential impact OWTS. An estimated 40 percent of OWTS are failing across Indiana (Rice 2005, p. 29; SJRWI 2008b, p. 68-69) and an estimated 98 percent of HSTS are failing in Williams County, Ohio (Ohio Department of Health [ODH] 2012). Thus, OWTS and HSTS are assumed to have localized impacts especially when failing OWTS or HSTS are near streams.

In the areas served by OWTS throughout the SJRW, when OWTS are near crop fields, illicit cross-connections between OWTS and agricultural drain tiles are possible. Such illicit cross-connections likely contribute nutrient and sediment loads. Illicit cross-connections of OWTS to agricultural drain tiles is assumed to contribute to ALU and RU impairments but is not considered to be a significant source.

F-1.5 Crop Production

Most of the subwatersheds in the Indiana-portion of the SJRW are predominantly agricultural with fields of row crops adjacent to rural residences, woodlots, and small ponds. Analyses of aerial imagery generally shows that streams throughout the SJRW are straightened and channelized without forested riparian buffers.

Land application of septage, biosolids, and manure is a potential source of nutrients and sediment because precipitation events result in agricultural runoff may transport land-applied septage, biosolids, and manure to surface streams.

F-1.5.1 Land Application of Septage

No septage land application is permitted in the Indiana-portion of the SJRW. Thus, septage is not considered to be a source of nutrients or sediment that contribute to IBC or nutrient impairments.

F-1.5.2 Land Application of Biosolids

Land application of biosolids was common in the 1990s; a summary of biosolids land application is presented in the discussions for each impaired subwatershed. However, little to no application data (e.g., volume, rates) are available for biosolids applications. As such, biosolids application is generally considered an historic source of nutrients and sediment loads and are assumed not to contribute to recent impairments.

F-1.5.3 Land Application of Manure

Manure application likely occurs on farms throughout the SJRW; the sources of such manure are hobby farms, small livestock operations, CFOs, and CAFOs. No application date, volume, or rate data are available; thus, the significance of manure application cannot be determined.

F-2. Aquatic Life Use Linkage Analysis

This section presents the ALU linkage analyses for 24 impaired segments in Indiana's portion of the SJRW:

- Dissolved oxygen (2 segments)
- Impaired biotic communities (18 segments)
- Nutrients (7 segments)

Dissolved oxygen and nutrient impairments were addressed through the development of total phosphorus (TP) total maximum daily loads (TMDLs) and impaired biotic communities (IBC) were addressed through TP TMDLs or total suspended solids (TSS) TMDLs, depending on which pollutants exceeded targets.

F-2.1 Project Area Data

Ambient water quality data and discharge monitoring report (DMR) data are summarized in this section.

F-2.1.1 Summary of Water Quality Data

In-stream, ambient water quality data were collected by IDEM and St. Joseph River Watershed Initiative (SJRWI). IDEM TP and TSS data (Table F-1) and SJRWI TP data (Table F-2) are summarized in tables by sample station.

Table F-1. Summary of TP and TSS data collected by IDEM

Waterbody	IDEM site ID	ALU segment status	TP (mg/L)				TSS (mg/L)			
			No.	Min.	Max.	GM	No.	Min.	Max.	GM
West Branch St. Joseph River (HUC 04100003 02)										
Headwaters Fish Creek (HUC 04100003 02 03)										
Clear Lake	LEJ020-0002	n/a	10	0.010	0.094	0.040	-	-	-	-
Lake Anne	LEJ020-0004	n/a	2	0.022	0.197	0.110	-	-	-	-
Round Lake	LEJ020-0003	n/a	4	0.010	0.032	0.020	-	-	-	-
Nettle Creek-St. Joseph River (HUC 04100003 03)										
Nettle Creek (HUC 04100003 03 01)										
Handy Lake	LEJ030-0002	n/a	2	0.010	0.127	0.069	-	-	-	-
Long Lake	LEJ030-0001	n/a	8	0.010	**0.652**	0.173	-	-	-	-
Mirror Lake	LEJ030-0003	n/a	2	0.050	0.148	0.099	-	-	-	-
Fish Creek (HUC 04100003 04)										
West Branch Fish Creek (HUC 04100003 04 01)										
West Branch Fish Creek	LEJ050-0020	Impaired	1	0.058	--	--	1	7	--	--
	LEJ050-0064	Impaired	7	0.025	0.100	0.079	7	5	17	8
Headwaters Fish Creek (HUC 04100003 04 02)										
Fish Creek	LEJ050-0023	Full	1	0.170	--	--	1	**38**	--	--
Hamilton Lake (HUC 04100003 04 03)										
Hamilton Lake.	LEJ050-0061	n/a	4	0.050	**0.630**	0.281	-	-	-	-
UT of Black Creek	LEJ050-0002	Full	1	0.120	--	--	1	21	--	--
Hiram Sweet Ditch (HUC 04100003 04 04)										
Ball Lake	LEJ050-0060	n/a	6	0.061	**0.440**	0.182	-	-	-	-
Fish Creek	LEJ050-0050	Full	2	0.015	0.032	0.024	2	7	9	8
	LEJ050-0052	Insufficient data	1	0.041	--	--	1	14	--	--
	LEJ050-0054	Insufficient data	1	0.083	--	--	1	20	--	--
Town of Alvarado-Fish Creek (HUC 04100003 04 05)										
Fish Creek	LEJ050-0010	Impaired	1	0.096	--	--	1	18	--	--
Fish Creek	LEJ050-0027	Impaired	1	0.130	--	--	1	18	--	18
Fish Creek	LEJ050-0006	Impaired	174	0.015	**1.800**	0.093	174	2	**256**	--
Fish Creek	LEJ050-0029	Impaired	1	0.220	--	--	1	**34**	--	--
Fish Creek	LEJ050-0032	Impaired	1	0.180	--	--	1	**35**	--	--
Fish Creek	LEJ050-0066	Impaired	3	0.120	0.300	0.193	3	5	**40**	19
UT of Fish Creek	LEJ050-0026	Full	1	0.220	0.220	0.220	1	10	10	10

Waterbody	IDEM site ID	ALU segment status	TP (mg/L)				TSS (mg/L)			
Cornell Ditch-Fist Creek (HUC 04100003 04 06)										
Fish Creek	LEJ050-0040	Impaired	1	0.160	--	--	1	**32**	--	--
	LEJ050-0008	Insufficient data	1	0.110	--	--	1	19	--	--
	LEJ050-0035	Insufficient data	1	0.120	--	--	1	16	--	--
	LEJ050-0007	Insufficient data	213	0.015	**0.415**	0.077	213	2	**280**	17
	LEJ050-0068	Insufficient data	3	0.100	0.220	0.170	3	13	**32**	21
UT of Fish Creek	LEJ050-0001	Impaired	4	0.260	**0.520**	**0.335**	4	23	**75**	**54**
	LEJ050-0048	Impaired	1	0.097	--	--	1	8	--	--
Sol Shank Ditch-St. Joseph River (HUC 04100003 05)										
Big Run (HUC 04100003 05 02)										
Big Run	LEJ050-0048	Impaired	4	0.160	0.250	0.215	4	5	18	10
Buck Creek (HUC 04100003 05 04)										
Metcalf Ditch	LEJ060-0002	Insufficient data	4	0.170	0.280	0.210	4	10	**41**	27
Hoodelmier Ditch-St. Joseph River (HUC 04100003 05 06)										
SJR	LEJ060-0006	Full	189	0.015	**0.650**	0.128	188	2	**348**	**36**
	LEJ060-0001	Full	3	0.160	**0.930**	**0.463**	3	**37**	**120**	**86**
Matson Ditch-Cedar Creek (HUC 04100003 06)										
Cedar Lake-Cedar Creek (HUC 04100003 06 01)										
Indian Lake	LEJ080-0012	n/a	4	0.010	0.162	0.075	0	--	--	--
UT of Leins Ditch	LEJ080-0014	Full	8	0.060	0.110	0.078	8	5	12	9
Leins Ditch	LEJ080-0016	Insufficient data	4	0.090	0.200	0.120	4	13	26	22
Cedar Creek	LEJ080-0005	Impaired	39	0.040	**0.340**	0.120	39	6	**164**	27
Matson Ditch (HUC 04100003 06 03)										
UT Mason Ditch	LEJ080-0013	Insufficient data	3	0.130	**0.360**	0.230	3	<10	18	11
Smith Ditch-Cedar Creek (HUC 04100003 06 04)										
West Smith Ditch	LEJ080-0017	Impaired	3	0.120	0.170	0.143	3	5	19	11
Cedar Creek (HUC 04100003 07)										
Headwaters John Diehl Ditch (HUC 04100003 07 01)										
Wiley Lake	LEJ090-0030	n/a	2	0.010	**0.828**	**0.419**	0	--	--	--
Peckhart Ditch-John Diehl Ditch (HUC 04100003 07 02)										
Peckhart Ditch	LEJ090-0040	Insufficient data	3	0.070	**0.320**	0.183	3	12	**51**	27
	LEJ090-0034	Insufficient data	4	0.100	0.130	0.113	4	12	19	15
Black Creek (HUC 04100003 07 04)										
Black Creek	LEJ090-0041	Impaired	4	0.120	0.140	0.130	4	5	**50**	18
King Lake-Little Cedar Creek (HUC 04100003 07 05)										
Little Cedar Creek	LEJ090-0033	Impaired	7	0.050	0.150	0.100	7	5	**40**	15
UT of Little Cedar Creek	LEJ090-0002	Impaired	3	0.075	0.180	0.115	3	6	**35**	17

Waterbody	IDEM site ID	ALU segment status	TP (mg/L)				TSS (mg/L)			
Dosch Ditch-Cedar Creek (HUC 04100003 07 07)										
Cedar Creek	LEJ090-0031	Impaired	7	0.140	0.160	0.149	7	5	25	14
Cedar Creek	LEJ090-0008	Impaired	31	0.040	0.290	0.103	34	2	**86**	16
Cedar Creek	LEJ090-0001	Impaired	4	0.110	**0.340**	0.210	4	7	**78**	**36**
Cedar Creek	LEJ090-0026	Impaired	146	0.015	**0.580**	0.100	145	2	**346**	26
Cedar Creek	LEJ090-0003	Impaired	3	0.150	**0.330**	0.240	3	5	**76**	**46**
Dosch Ditch	LEJ090-0004	Impaired	3	0.072	0.150	0.117	3	6	15	11
St. Joseph River (HUC 04100003 08)										
Bear Creek (HUC 04100003 08 01)										
Bear Creek	LEJ070-0002	Full	1	0.180	--	--	1	26	--	--
Metcalf Ditch-St. Joseph River (HUC 04100003 08 02)										
SJR	LEJ070-0001	Full	4	0.110	**0.510**	0.228	4	**33**	**350**	**140**
Swartz Cannahan Ditch-St. Joseph River (HUC 04100003 08 03)										
Dunton Lake	LEJ070-0023	n/a	2	0.010	**0.968**	**0.489**	0	--	-	-
SJR	LEJ070-0027	Full	7	0.130	0.230	0.171	7	10	**39**	26
	LEJ070-0026	Full	7	0.100	0.150	0.126	7	18	**39**	28
Cedarville Reservoir-St. Joseph River (HUC 04100003 08 04)										
Cedarville Reservoir	LEJ070-0022	n/a	2	0.162	0.167	0.165	0	--	--	--
SJR	LEJ070-0028	Insufficient data	4	**0.330**	**0.730**	**0.480**	4	**46**	**130**	**68**
Ely Run-St. Joseph River (HUC 04100003 08 05)										
SJR	LEJ100-0002	Full	103	0.015	**0.910**	0.150	104	2	**856**	**46**
Becketts Run-St. Joseph River (HUC 04100003 08 06)										
Becketts Run	LEJ100-0001	Insufficient data	3	0.034	**0.310**	0.151	3	8	**130**	**50**
SJR	LEJ100-0026	Impaired	3	0.260	**0.760**	**0.430**	3	23	**140**	**65**
	LEJ-08-0005	Impaired	44	0.040	**0.630**	0.129	44	6	**174**	29
	LEJ100-0023	Full	2	0.156	0.165	0.161	0	--	--	--
	LEJ100-0003	Full	257	0.015	**0.570**	0.145	259	2	**434**	**40**

Source: IDEM 2014, 2015b
Notes
n/a = not applicable because the listed waterbody is a lake
Bolded minima, maxima, and averages exceed the TP or TSS targets of 0.3 mg/L and 30 mg/L, respectively.

Table F-2. Summary of TP (mg/L) data collected by SJRWI

Stream name	Site ID	No.	Min.	Max.	Average
Fish Creek (HUC 04100003 04)					
Cornell Ditch-Fish Creek (HUC 04100003 04 06)					
Fish Creek	124	203	0.010	**1.256**	0.112
Sol Shank Ditch-St. Joseph River (HUC 04100003 05)					
Bluff Run-St. Joseph River (HUC 04100003 05 01)					
Bluff Run	162	75	0.035	**0.599**	0.158
Big Run-St. Joseph River (HUC 04100003 05 02)					
Big Run-West	159	87	0.025	**0.401**	0.093
Big Run	127	203	0.010	**0.938**	0.140
Russell Run-St. Joseph River (HUC 04100003 05 03)					
Russel Run-N.	161	50	0.025	**0.544**	0.126
Russel Run-S.	160	50	0.035	**0.558**	0.204
Buck Creek (HUC 04100003 05 04)					
Buck Creek	158	84	0.025	**4.607**	0.128
Willow Run-St. Joseph River (HUC 04100003 05 05)					
Willow Run	156	18	0.025	**0.428**	0.169
SJR	163	29	0.022	**0.242**	0.089
Hoodelmier Ditch-St. Joseph River (HUC 04100003 05 06)					
Shank Ditch-W.	157	47	0.025	**1.253**	0.162
Shank Ditch	123	203	0.010	**1.480**	0.123
Matson Ditch-Cedar Creek (HUC 04100003 06)					
Dibbling Ditch-Cedar Creek (HUC 04100003 06 02)					
Dibbling Ditch	143	115	0.010	**1.041**	0.153
David Link Ditch	142	175	0.020	**0.750**	0.124
Matson Ditch (HUC 04100003 06 03)					
Matson Ditch	106	329	0.010	**1.645**	0.143
Smith Ditch-Cedar Creek (HUC 04100003 06 04)					
Walter Smith D.	141	317	0.010	**9.564**	0.219
Upper Cedar Cr.	105	29	0.022	**0.762**	0.101
Cedar Creek (HUC 04100003 07)					
Peckhart Ditch-John Diehl Ditch (HUC 04100003 07 02)					
Diehl/Peckhart D.	104	326	0.010	**1.215**	0.124
Black Creek (HUC 04100003 07 04)					
Black Creek	102	115	0.010	**0.956**	0.141
King Lake-Little Cedar Creek (HUC 04100003 07 05)					
Little Cedar Cr.	103	175	0.010	**1.123**	0.120
Willow Creek (HUC 04100003 07 06)					
Willow Creek	101	175	0.010	**0.474**	0.094
Dosch Ditch-Cedar Creek (HUC 04100003 07 07)					
Garrett City Ditch	117	175	0.020	**1.096**	0.236
Cedar Creek	100	354	0.010	**0.848**	0.125
St. Joseph River (HUC 04100003 08)					
Bear Creek (HUC 04100003 08 01)					
Bear Creek-IN	128	191	0.010	**1.891**	0.132
Metcalf Ditch-St. Joseph River (HUC 04100003 08 02)					
Metcalf Ditch	149	9	0.010	**1.181**	0.238
Swartz Cannahan Ditch-St. Joseph River (HUC 04100003 08 03)					
SJR	121	29	0.022	**1.036**	0.125
Cedarville Reservoir-St. Joseph River (HUC 04100003 08 04)					
SJR	122	29	0.022	**0.667**	0.140

Stream name	Site ID	No.	Min.	Max.	Average
Ely Run-St. Joseph River (HUC 04100003 08 05)					
Ely Run	150	124	0.010	**0.946**	0.174

Source: SJRWI 2014, 2015
Notes
Bolded minima, maxima, and averages exceed the TP target of 0.3 mg/L.

F-2.1.2 Summary of Discharge Monitoring Report Data

Discharge monitoring report (DMR) data for permitted facilities were provided by IDEM. The DMR TP (Table F-3) and TSS (Table F-4) concentration and load data are summarized by permitted facility.

Table F-3. Summary of DMR data for facilities permitted to discharge TP in Indiana

NPDES ID	Outfall	Flow (cfs)				TP concentration (mg/L)				TP load (lbs/d)			
		No. [a]	Min.	Max.	Avg.	No. [a]	Min.	Max.	Avg.	No. [a]	Min.	Max.	Avg.
Fish Creek (HUC 04100003 04)													
Hiram Sweet Ditch (HUC 04100003 04 04)													
IN0050822	001	132	0.202	0.398	0.280	132	0.19	89.40	1.15	132	0.231	125.341	1.661
Sol Shank Ditch-St. Joseph River (HUC 04100003 05)													
Big Run-St. Joseph River (HUC 04100003 05 02)													
IN0022462	001	20	0.885	2.299	1.383	20	0.20	0.50	0.30	20	1.297	3.643	2.159
	002	111	1.017	2.825	1.707	110	0.02	1.20	0.39	110	0.107	10.955	3.521
Sol Shank Ditch-St. Joseph River (HUC 04100003 05 06)													
IN0059021	005	0	--	--	--	4	<0.04	1.01	0.28	0	--	--	--
Matson Ditch-Cedar Creek (HUC 04100003 06)													
Dibbling Ditch-Cedar Creek (HUC 04100003 06 02)													
IN0020711	001	132	0.174	8.955	0.521	132	0.2	1.3	0.6	132	0.318	18.919	1.591
Smith Ditch-Cedar Creek (HUC 04100003 06 04)													
IN0000868	001	0	--	--	--	7	<0.04	0.12	0.09	0	--	--	--
IN0000566	001	57	0.034	0.259	0.168	3	<0.10	<0.10	<0.10	3	0.019	0.064	0.039
	002	74	0.104	0.706	0.242	3	<0.10	19.70	6.60	3	0.036	56.095	18.767
Cedar Creek (HUC 04100003 07)													
Peckhart Ditch-John Diehl Ditch (HUC 04100003 07 02)													
IN0061263	001	50	<0.001	0.366	0.052	8	0.025	>0.100	0.065	7	<0.001	0.152	0.030
Sycamore Creek-Little Cedar Creek (HUC 04100003 07 03)													
IN0020664	001	132	0.053	0.820	0.529	132	0.20	0.90	0.50	132	0.197	3.118	1.471
Dosch Ditch-Cedar Creek (HUC 041100003 07 07)													
IN0029969	001	89	0.722	1.938	1.137	89	0.20	1.50	0.52	89	1	13	3

Source: IDEM EPA 2015a

Notes

The following are excluded from this table: (1) facilities not permitted to discharge total phosphorus, and (2) facilities without total phosphorus DMR data.

a. Number of DMR records for the specified parameter.

Table F-4. Summary of DMR data for facilities permitted to discharge TSS in Indiana

NPDES ID	Outfall	Flow (cfs)				TSS concentration (mg/L)				TSS load (lb/day)			
		No. [a]	Min.	Max.	Avg.	No. [a]	Min.	Max.	Avg.	No. [a]	Min.	Max.	Avg.
Fish Creek (HUC 04100003 04)													
Hiram Sweet Ditch (HUC 04100003 04 04)													
IN0060216	001	80	0.003	0.332	0.026	80	1	7	3	80	<1	6	<1
IN0050822	001	84	0.202	0.373	0.272	84	2	19	5	84	2	31	8
Sol Shank Ditch-St. Joseph River (HUC 04100003 05)													
Big Run-St. Joseph River (HUC 04100003 05 02)													
IN0022462	002	84	1.017	2.825	1.725	84	2	12	6	84	15	140	53
Matson Ditch-Cedar Creek (HUC 04100003 06)													
Dibbling Ditch-Cedar Creek (HUC 04100003 06 02)													
IN0020711	001	84	0.174	1.067	0.455	84	<1	12	4	84	<1	55	10
Smith Ditch-Cedar Creek (HUC 04100003 06 04)													
IN0000868	001	84	0.400	0.937	0.656	84	<1	12	3	84	2	44	11
IN0000566	001	10	0.073	0.237	0.171	10	2	11	4	10	1	8	4
IN0000566	002	74	0.104	0.706	0.242	74	1	19	2	74	1	23	2
IN0020672	001	84	2.334	7.883	4.181	84	1	6	3	84	16	183	61
Cedar Creek (HUC 04100003 07)													
Headwaters John Diehl Ditch (HUC 04100003 07 01)													
IN0047473	001	83	0.006	0.126	0.020	39	2	56	12	39	<1	6	1
Peckhart Ditch-John Diehl Ditch (HUC 04100003 07 02)													
IN0061263	001	50	<0.001	0.366	0.052	43	<1	37	6	43	<1	14	2
Sycamore Creek-Little Cedar Creek (HUC 04100003 07 03)													
IN0052035	001	84	0.030	0.051	0.037	83	<1	19	6	83	<1	4	1
IN0020664	001	84	0.053	0.819	0.514	84	2	15	7	84	1	49	21
IN0029955	001	32	0.002	0.011	0.006	32	4	26	11	32	<1	<1	<1
Black Creek (HUC 04100003 07 04)													
IN0058611	001	80	0.002	0.066	0.035	23	2	80	24	23	<1	21	5
King Lake-Little Cedar Creek (HUC 04100003 07 05)													
IN0032107	001	47	0.001	0.032	0.008	47	1	25	8	47	<1	2	<1
Dosch Ditch-Cedar Creek (HUC 04100003 07 07)													
IN0022969	001	84	0.722	1.938	1.134	84	3	14	6	84	13	115	34
St. Joseph River (HUC 04100003 08)													
Hursey Ditches-Bear Creek (HUC 04100003 08 01)													
IN00032981	001	19	0.009	0.141	0.038	19	8	275	76	19	<1	102	17

NPDES ID	Outfall	Flow (cfs)				TSS concentration (mg/L)				TSS load (lb/day)			
		No. [a]	Min.	Max.	Avg.	No. [a]	Min.	Max.	Avg.	No. [a]	Min.	Max.	Avg.
Swartz Cannahan Ditch-St. Joseph River (HUC 04100003 08 03)													
IN0059749	001	76	0.001	0.020	0.010	76	3	23	10	76	<1	2	<1
IN0063061	001	75	0.011	0.116	0.013	75	<1	30	4	75	<1	6	<1
Cedarville Reservoir-St. Joseph River (HUC 04100003 08 04)													
IN0044369	001	84	0.063	0.995	0.114	84	1	14	4	84	<1	25	2
Becketts Run-St. Joseph River (HUC 04100003 08 06)													
IN0060127	001	3	0.041	0.063	0.056	3	8	21	13	3	3	5	3

Source: 2015a
Notes
The following are excluded from this table: (1) facilities not permitted to discharge TSS, and (2) facilities without TSS DMR data.
Treated effluent is discharged through outfall 001.
a. Number of DMR records for the specified parameter.

F-2.2 West Branch Fish Creek (HUC 04100003 04 01)

West Branch Fish Creek is in Indiana and the subwatershed is bisected by the Indiana East-West Toll Road (I-80) and U.S. route 20. The subwatershed is agricultural with many woodlots. Rural residential properties are adjacent to cultivated crop fields and pastures.

F-2.2.1 Monitoring Data

IDEM collected water chemistry samples at two sites on the West Branch Fish Creek (LEJ050-20 and LEJ050-064), just upstream of the confluence with Fish Creek; both sites are on segment INA0341_02. TP (0.058 mg/L) and TSS (7 mg/L) in the single sample collected at site LEJ050-020 were below the TP (0.30 mg/L) and TSS (30 mg/L) targets. Additionally, as shown in Table F-1, TP and TSS concentrations from all seven samples collected at site LEJ050-064 were below targets.

IDEM listed two segments of the West Branch Fish Creek (INA0341_01 and INA0341_02) for IBC. Such listings are addressed via TP and TSS TMDLs when one or both parameters exceeds its target. Since neither TP results nor TSS results exceed targets, TMDLs were not developed to address IBC listings on West Branch Fish Creek.

F-2.2.2 Load Duration Curve

Since no TP or TSS sample results exceeded targets, no load duration curves (LDCs) nor TMDLs were developed.

F-2.2.3 Sources of Impairment

Nutrient and sediment sources were not assessed because these pollutants are not the cause of impairment. During the development of the point sources inventory, no permitted point sources were identified in this subwatershed[3]. However, the Angola Municipal Sewage Treatment Plant (STP) was permitted to land apply biosolids to 20 fields in this subwatershed (Figure C-3 in Appendix C).

While IDEM provided field locations of biosolids land applications, the following data are sparse: application dates, methods, and rates (Table C-11). Except for a single application in 2003, biosolids land applications in this watershed occurred from 1990 through 1995. Since biosolids application has not occurred in this HU during the last decade, biosolids did not likely contribute to the IBC.

[3] No public or private facilities with individual or general NPDES permits, communities with combined sewer overflows (CSOs) or sanitary sewer overflows (SSOs), or regulated municipal separate storm sewer systems (MS4s) are in this subwatershed.

F-2.3 Town of Alvarado-Fish Creek (HUC 04100003 04 05)

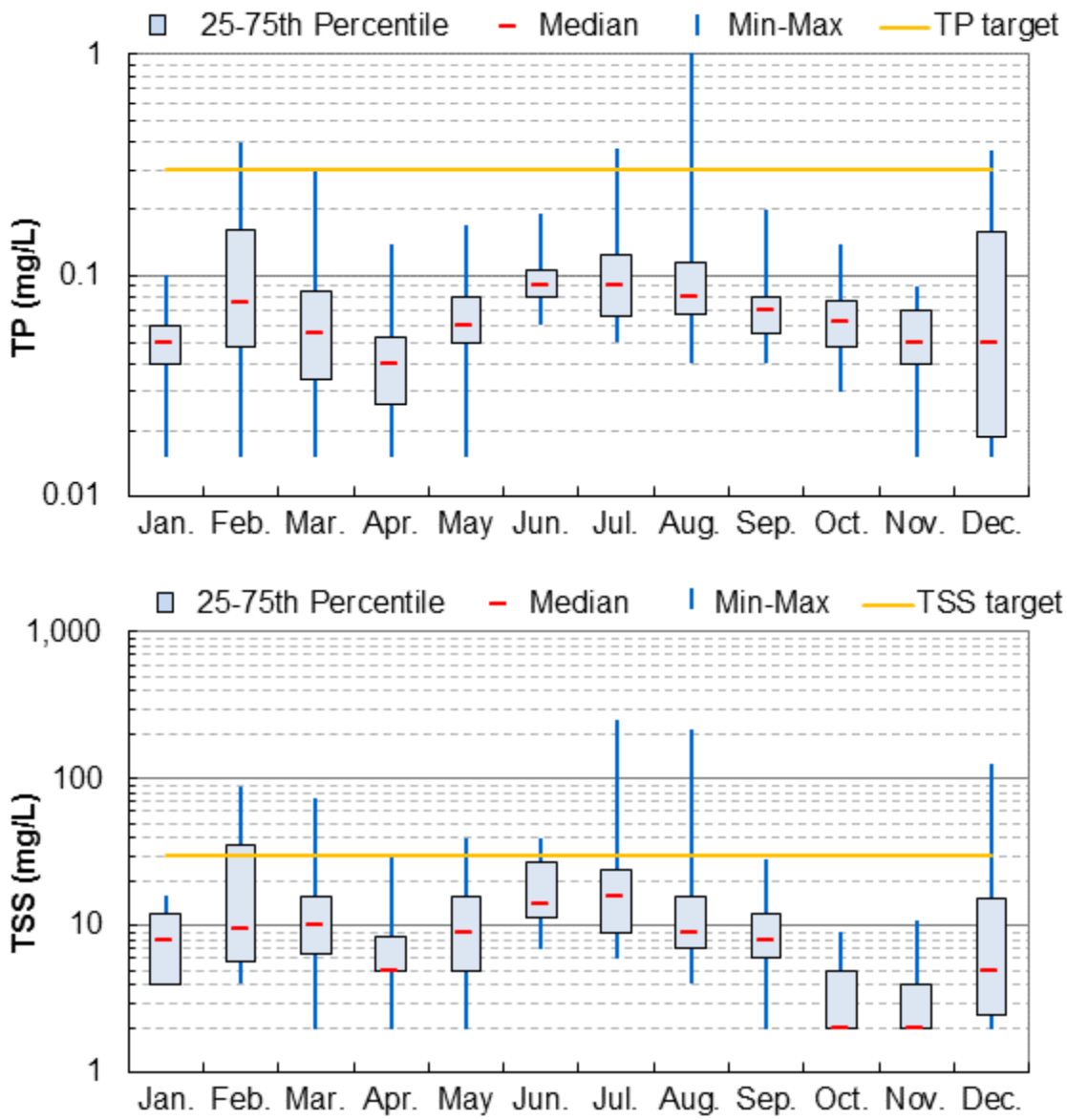
This subwatershed begins in Indiana at the confluence of West Branch Fish Creek with Fish Creek. After the confluence, Fish Creek flows southerly toward the Ohio-Indiana border before it then flows southwest away from the border. The landscape is dominate by crop agriculture with some woodlots, especially along Fish Creek. Rural residences are throughout the subwatershed.

F-2.3.1 Monitoring Data

IDEM collected water chemistry samples at six sites on Fish Creek (LEJ050-0006, LEJ050-0010, LEJ050-0027, LEJ050-0029, LEJ050-0032, and LEJ050-0066) and one site (LEJ050-0026) on an unnamed tributary to Fish Creek.

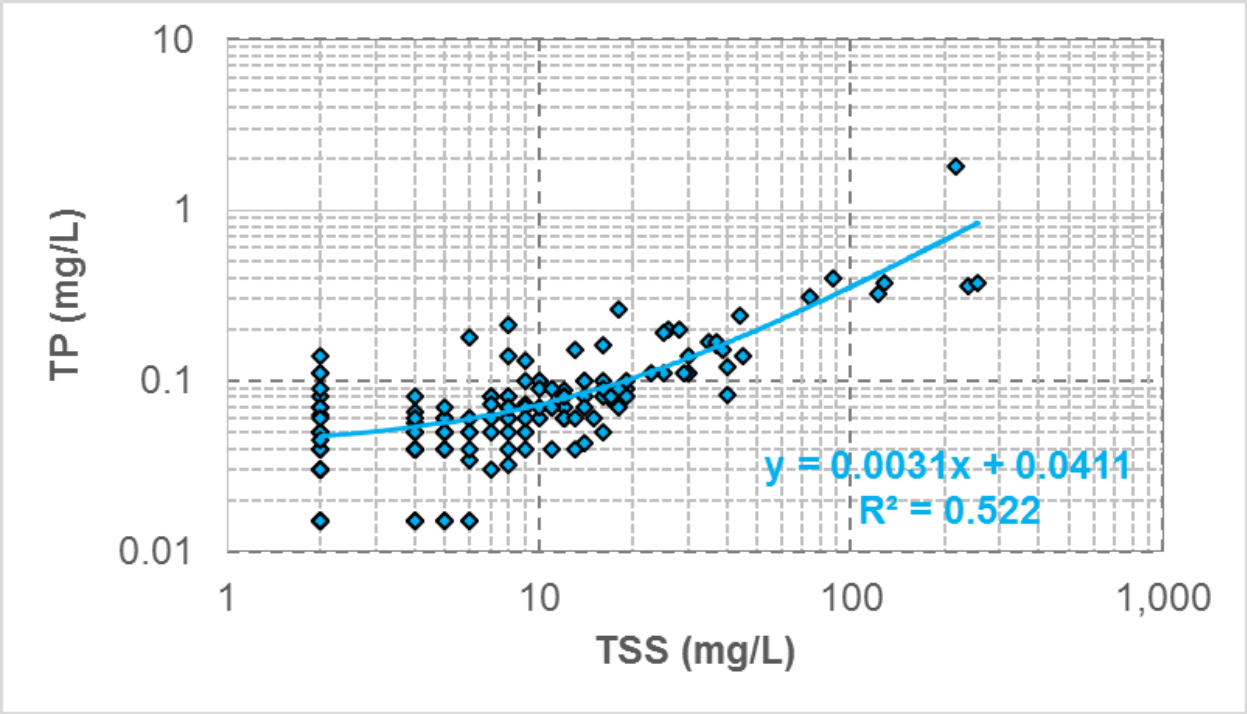
TP results from the single samples collected on Fish Creek at the four sites were below the target of 0.30 mg/L, while the TSS target (30 mg/L) was exceeded twice (Table F-1). Only one TSS result from the three samples collected at site LEJ050-0066 exceeded the target. The TP and TSS results from the single sample collected at site LEJ050-0026 on an unnamed tributary to Fish Creek were below the targets. Long-term data collected at site LEJ050-0006 indicates that the TP and TSS targets are occasionally exceeded.

Long-term data collected at site LEJ050-0006 are summarized in Figure F-1. TP and TSS increase in the spring and decrease in the late summer and fall. TSS was not detected in 17 percent of samples. A linear regression of TSS and TP (R^2=0.52) at site LEJ050-0006 may indicate a predictive relationship. Such results likely indicate that TP is bound to sediment. When TP is sediment-bound, sources of sediment erosion (both upland and in-channel) typically increase the in-stream concentrations of TP and TSS.



Notes
The August TP maximum is 1.80 mg/L.
161 samples collected 1999-2014.

Figure F-1. TP (top) and TSS (bottom) at site LEJ050-0006 on Fish Creek.



Note: Non-detects were included in this analysis as one-half of the detection limit.

Figure F-2. Paired TP and TSS samples at site LEJ050-0006.

Dissolved oxygen data can indicate nutrient impairment. At long-term site LEJ050-0006, DO was measured when water chemistry samples were collected. Continuous DO data are not available. Instantaneous DO ranged from 4.8 to 16.2 mg/L. Over 97 percent of sample results were 6 mg/L or greater.

IDEM listed segment INA0345_01 of Fish Creek for IBC and DO. As TP and TSS both occasionally exceed targets, the IBC listing was addressed through the development of TP and TSS TMDLs at the outlet of the subwatershed.

F-2.3.2 Load Duration Curve

A LDC was developed for Fish Creek (Figure F-3 and Figure F-4) and TP or TSS data collected by IDEM in 2004-2014 are displayed as loads[4]. Exceedances of the LDC only occurred in the high flow and moist conditions flow zones for TP and in the high flow, moist conditions, and mid-range flow zones for TSS. To achieve the TMDL (i.e., reduce loads to the LDC), reductions on a per sample basis, for the samples that exceed the TMDL target, range from 2 to 83 percent for TP and range from 14 to 88 for TSS.

[4] TP and TSS concentrations from IDEM samples were multiplied by SWAT-simulated flows and converted to appropriate units.

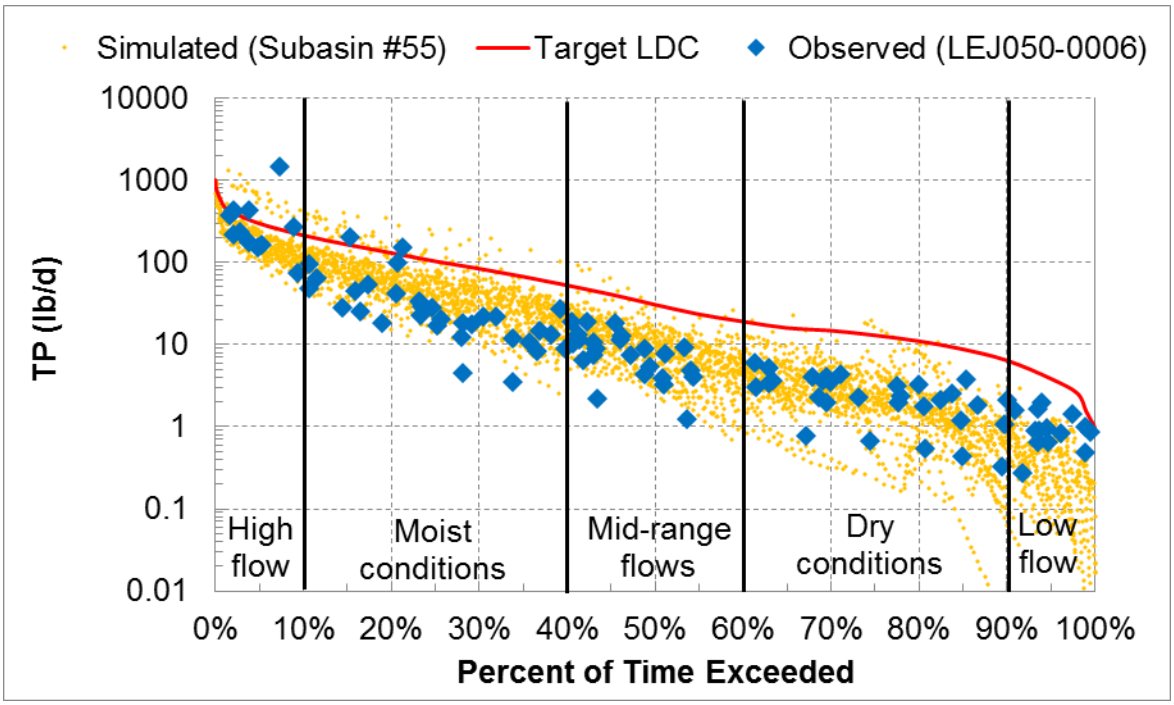


Figure F-3. TP loads and LDC for Fish Creek in *Town of Alvarado-Fish Creek* (*04 05) at the HU outlet.

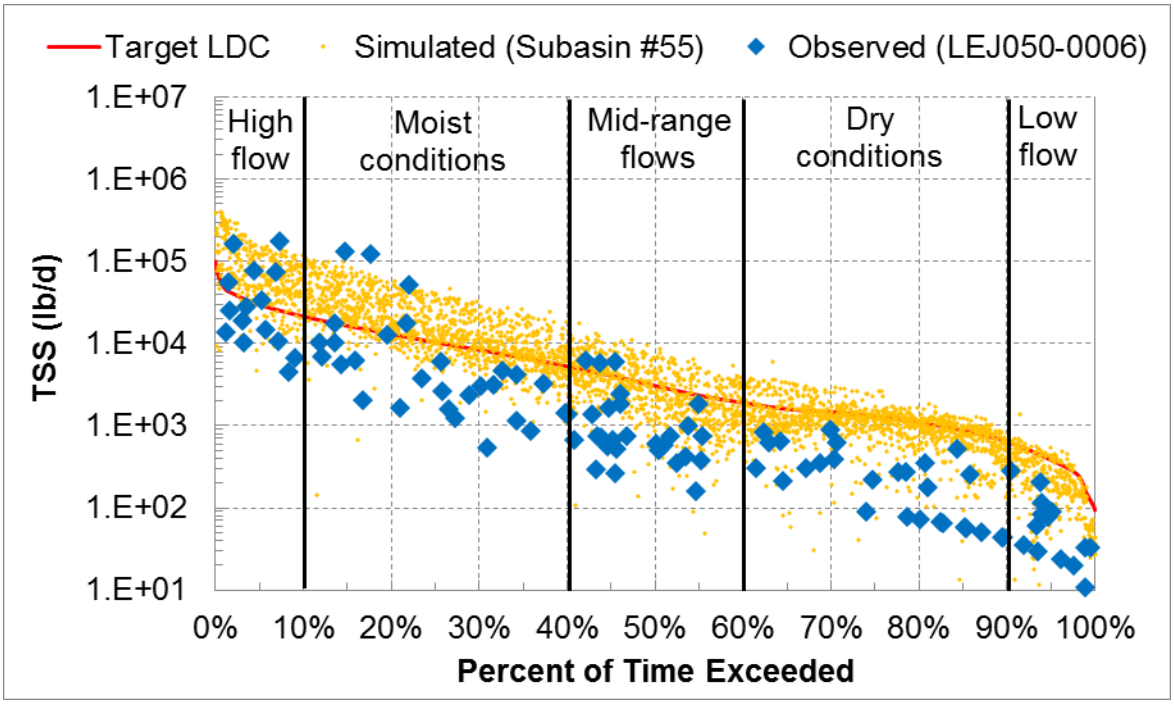
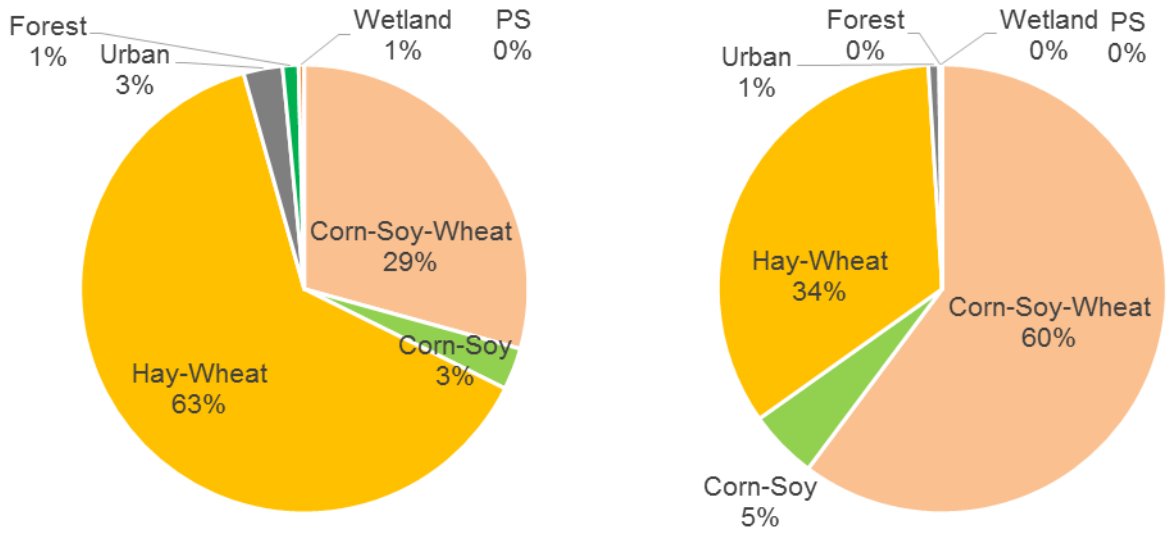


Figure F-4. TSS loads and LDC for Fish Creek in *Town of Alvarado-Fish Creek* (*04 05) at the HU outlet.

F-2.3.3 Sources of Impairment

SWAT-simulated source loads[5] indicate that crops are the dominant source of TP and TSS load to Fish Creek in this HU (Figure F-5). In this multi-state TMDL subwatershed, 82 percent of the TP source load is from Indiana and 18 percent from Ohio; these results do not account for in-stream processes. Similarly, for TSS, 85 percent is from Indiana and 15 percent from Ohio.



Notes
Relative loads are rounded to the nearest percentage point.
No point sources were simulated.
SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) and the loads derived from model inputs for certain point sources. Such loads are inputs to the model reaches and do not account for in-stream processes. Results are summarized as the 11-year average of annual loads by source category.

Figure F-5. Summary of SWAT-simulated annual TP (left) and TSS (right) loads that drain to Fish Creek at the outlet of Town *of Alvarado-Fish Creek* (*04 05).

The potential sources of nutrients in this HU are evaluated in the following sections.[6]

F-2.3.3.1 On-Site Wastewater Treatment Systems

Except for the Hamilton Lake area, OWTS treat commercial and domestic wastewater. No permitted off-site discharging HSTS are in the Ohio-portion of this subwatershed. As this subwatershed is mostly composed of crop fields and woodlots, illicit cross-connections between OWTS and agricultural drain tiles are likely. Grandfathered or illicit off-site discharging OWTS, failing on-lot OWTS, and illicit OWTS connections to drain tiles likely contribute TP and TSS loads.

F-2.3.3.2 Unregulated Livestock Operations

No CAFOs, CFOs, or concentrated animal feeding facilities (CAFFs; state permit issued by Ohio) are in this subwatershed. No information about hobby farms and small livestock operations are available but

[5] SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) within a single model subbasin. These loads also include model inputs from certain point sources (e.g., WWTPs). Such loads are inputs to the model reaches and do not account for in-stream processes. These loads are plotted as annual average loads across the 11-year SWAT model simulation period. As the TMDL subwatersheds are composed of multiple model subbasins, the results per subbasin are summed.

[6] No industrial or public facilities with individual or general NPDES permits, biosolids application fields, communities with CSOs or SSOs, or regulated MS4s are in this subwatershed.

such operations are likely present throughout the subwatershed. Within the TMDL subwatershed, SJRWI (2008a) observed livestock during windshield surveys at 25 locations in Indiana and 14 locations in Ohio; no manure storage or livestock direct access to streams were observed. At the 25 locations in Ohio, SJRWI (2008a) estimated 2 to 12 animals at 21 locations, 50 and 75 beef cattle at two locations, and 80 and 120 dairy cattle at two locations. No additional information about hobby farms and small livestock operations are available. Thus, livestock in Indiana and Ohio may contribute nutrients or sediment that impair biotic communities.

F-2.3.3.3 Crop Production

As shown in Figure F-5, cropland is the dominant source of TP loading in the TMDL subwatershed. Most of this subwatershed is agricultural land, with some woodlots along Fish Creek and its tributaries. An analysis of aerial imagery shows that, with the exception of Fish Creek, streams throughout this subwatershed are channelized and straightened, especially when flowing through crop fields. Fish Creek meanders through large woodlots near the outlet of this subwatershed.

F-2.4 Cornell Ditch-Fish Creek (HUC 04100003 04 06)

Fish Creek flows through predominantly agricultural land with few residences and few woodlots in Indiana and Ohio. Only Fish Creek has a forested riparian corridor. The confluence of Fish Creek with the St. Joseph River is in Ohio just upstream of the city of Edgerton.

F-2.4.1 Monitoring Data

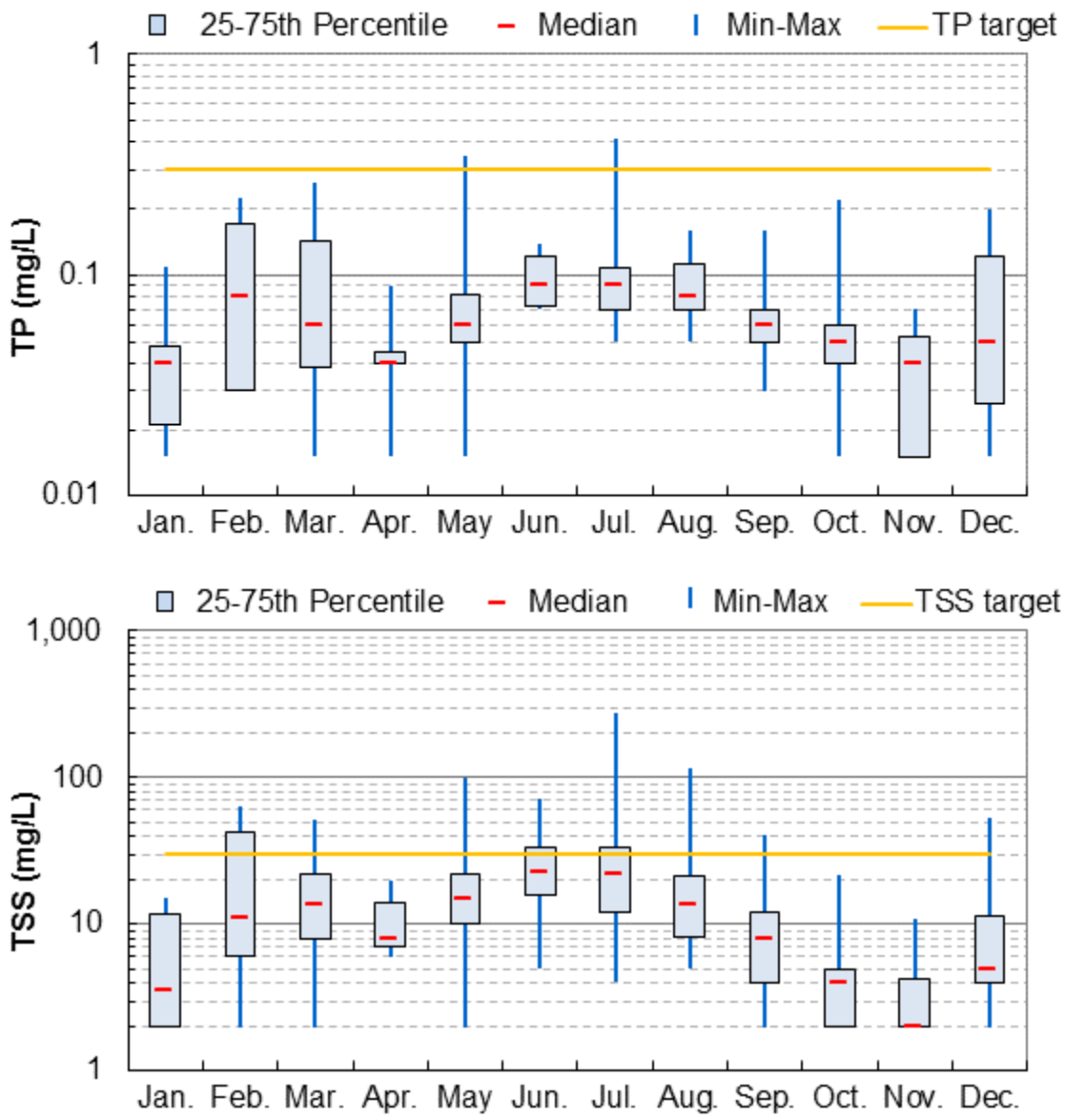
Samples were collected by IDEM (Section F-2.4.1.1), Ohio EPA (Section F-2.4.1.2), SJRWI (Section F-2.4.1.3), and USGS (Section F-2.4.1.4). IDEM listed segment INA0346_01 of Fish Creek and segment INA0346_T1003 of the unnamed tributary to Fish Creek for IBC. As TP and TSS both occasionally exceed targets, the IBC listings were addressed through the development of TP and TSS TMDLs at the Ohio-Indiana state line on Fish Creek.

F-2.4.1.1 IDEM

IDEM collected water chemistry samples at seven sites on Fish Creek (LEJ050-0007, LEJ050-0008, LEJ050-0011, LEJ050-0012, LEJ050-0035, LEJ050-0040, and LEJ050-0068) and at two sites on an unnamed tributary to Fish Creek (LEJ050-0001 and LEJ050-0048).

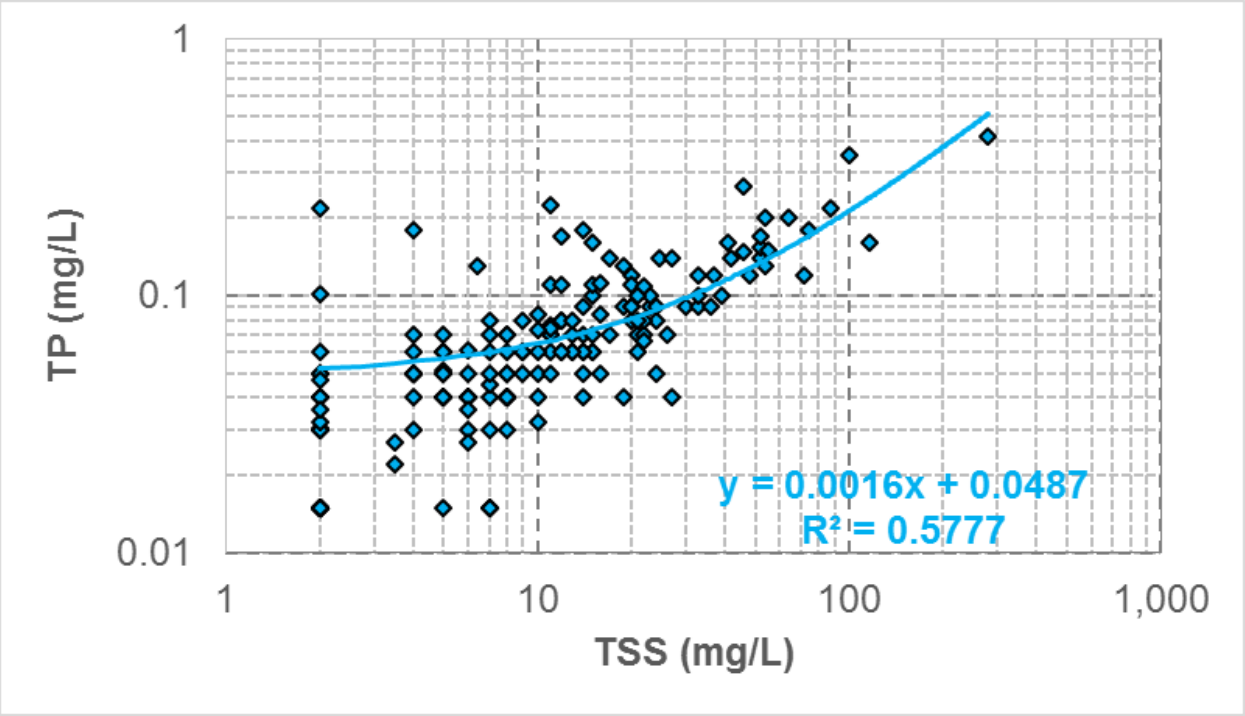
In Indiana, water chemistry samples from five sites on Fish Creek and two sites on its unnamed tributary were evaluated for nutrients. As show in Table F-1, TP results at sites LEJ050-001 and LEJ050-0007 indicated impairment while TSS results at those two sites and two additional sites indicate impairment.

Long-term data collected at site LEJ050-0007 are summarized in Figure F-6. TP and TSS increase in the spring and decrease in the late summer and fall. A linear regression of TSS and TP (R^2=0.58) at site LEJ050-0007 may indicate a predictive relationship. Such results likely indicate that TP is bound to sediment. When TP is sediment-bound, sources of sediment erosion (both upland and in-channel) typically increase the in-stream concentrations of TP and TSS.



Note: 179 samples collected 1999-2014.

Figure F-6. TP (top) and TSS (bottom) at site LEJ050-0007 on Fish Creek.



Note: Non-detects were included in this analysis as one-half of the detection limit.

Figure F-7. Paired TP and TSS samples at site LEJ050-0007.

Dissolved oxygen data can indicate nutrient impairment. At long-term site LEJ050-0007, DO was measured when water chemistry samples were collected. Continuous DO data are not available. Instantaneous DO ranged from 4.6 to 14.5 mg/L. Over 97 percent of sample results were 6 mg/L or greater.

F-2.4.1.2 Ohio EPA

Ohio EPA collected water chemistry samples from three sites on Fish Creek (P08K09, P08K10, and P08S20). TP concentrations varied considerably in 2013 (0.015 – 0.339 mg/L); 15 of 24 samples exceed their respective wading WWH (0.1 mg/L) or EWH (0.05 mg/L) targets, while only one sample exceeded the Indiana target (0.3 mg/L). TSS concentrations ranged from non-detect to 176 mg/L. Four of 24 samples were non-detect. Six samples exceeded Ohio (29 mg/L) and Indiana (30 mg/L) TSS targets.

All three sites were in full attainment of their WWH or EWH ALU and Ohio EPA did not list this WAU as impaired.

F-2.4.1.3 SJRWI

SJRWI collected 203 samples at site 124 (Table F-2) that is collocated with Ohio EPA site P08S20. Most samples were collected from 2008 through 2014.Ten of 153 samples evaluated for TP exceeded the Indiana target (0.3 mg/L).

F-2.4.1.4 USGS

USGS historically recorded daily flow on Fish Creek at Artic, IN (04177810; 1988-2007) and collected water chemistry samples on Fish Creek near Edgerton, OH (04177820). Suspended sediment concentration was recorded at gage 04177810 from April 1998 through water year 2007. Six samples collected at site 04177820 from 1972 through 1977 yield TP concentrations from 0.03 to 0.09 mg/L.

F-2.4.2 Load Duration Curve

LDCs were developed for Fish Creek (Figure F-8 and Figure F-9) and TP or TSS data collected by IDEM in 2004-2014 are displayed as loads[7]. Exceedances of the LDC only occurred in the high flow and moist conditions flow zones for TP and in the high flow and moist conditions zones for TSS. To achieve the TMDLs (i.e., reduce loads to the LDCs), reductions on a per sample basis, for the samples that exceed the TMDL target, range from 14 to 28 percent for TP and range from 9 to 89 for TSS.

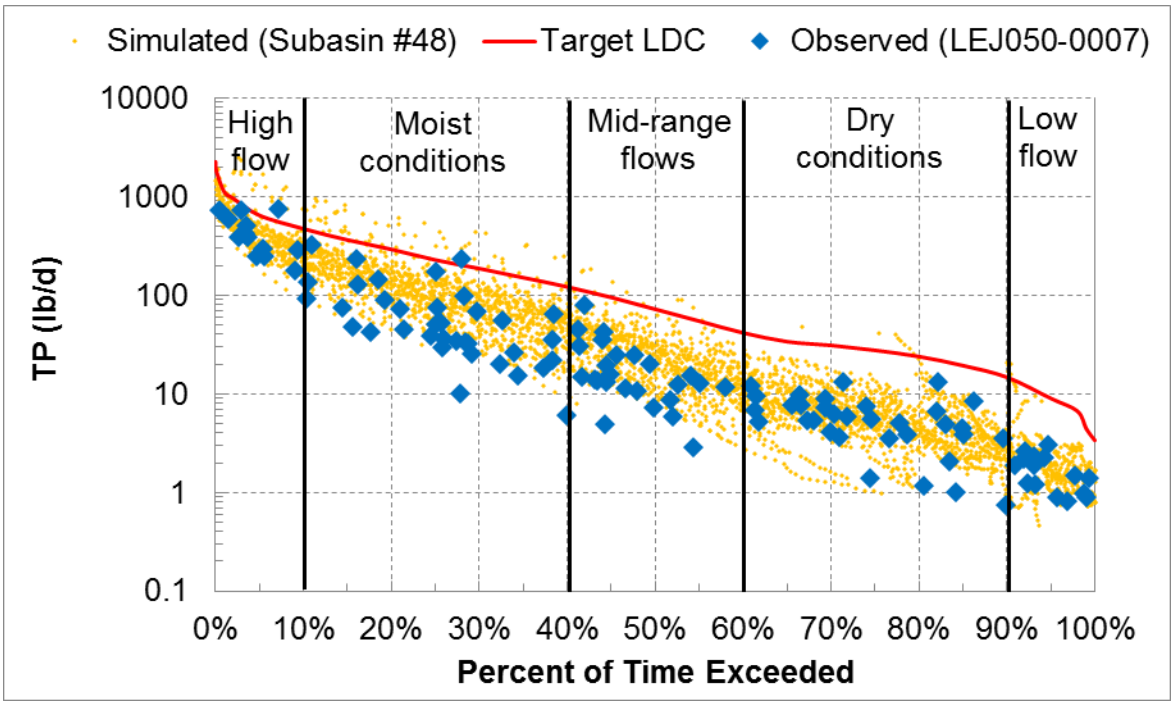


Figure F-8. TP loads and LDC for Fish Creek in *Cornell Ditch-Fish Creek* (*04 06) at the HU outlet.

[7] TP and TSS concentrations from IDEM samples were multiplied by SWAT-simulated flows and converted to appropriate units.

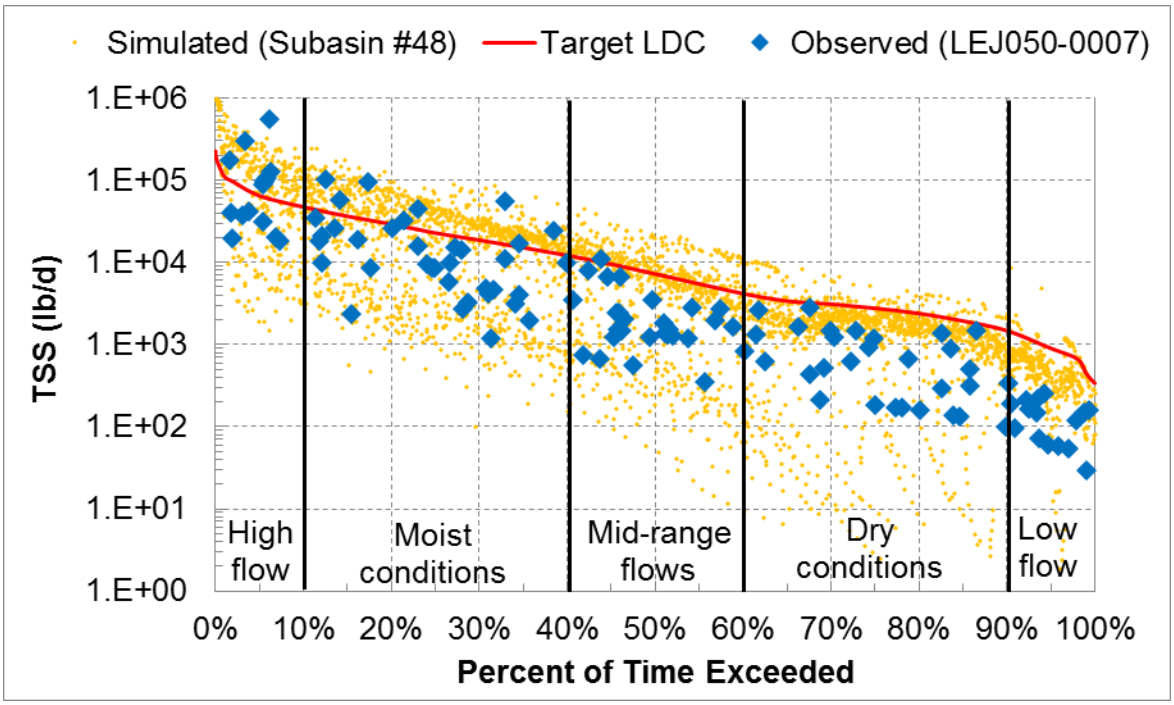
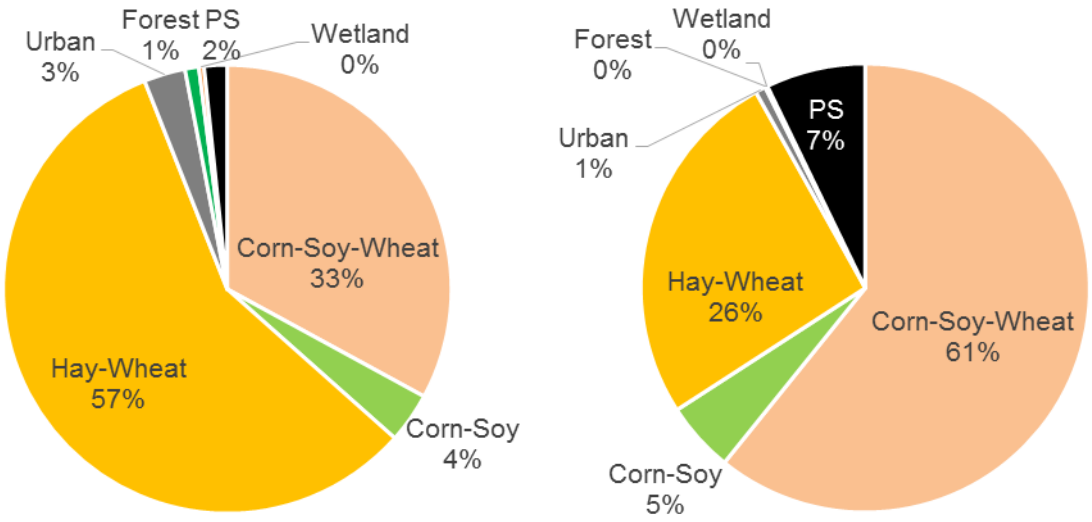


Figure F-9. TSS loads and LDC for Fish Creek in *Cornell Ditch-Fish Creek* (*04 06) at the HU outlet.

F-2.4.3 Sources of Impairment

SWAT-simulated source loads[8] indicate that crops are the dominant source of TP and TSS load to Fish Creek in this HU (Figure F-10). In this multi-state TMDL subwatershed, 92 percent of the TP source load is from Indiana and 8 percent from Ohio; these results do not account for in-stream processes. Similarly, for TSS, 94 percent is from Indiana and 6 percent from Ohio.

[8] SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) within a single model subbasin. These loads also include model inputs from certain point sources (e.g., WWTPs). Such loads are inputs to the model reaches and do not account for in-stream processes. These loads are plotted as annual average loads across the 11-year SWAT model simulation period. As the TMDL subwatersheds are composed of multiple model subbasins, the results per subbasin are summed.



Notes
"PS" = permitted point sources.
Relative loads are rounded to the nearest percentage point.
SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) and the loads derived from model inputs for certain point sources. Such loads are inputs to the model reaches and do not account for in-stream processes. Results are summarized as the 11-year average of annual loads by source category.

Figure F-10. Summary of SWAT-simulated annual TP (left) and TSS (right) loads that drain to Fish Creek at the outlet of *Cornell Ditch-Fish Creek* (*04 06).

The potential sources of nutrients in this HU are evaluated in the following sections.[9]

F-2.4.3.1 On-Site Wastewater Treatment Systems

As no publicly owned treatment works (POTWs) are in this subwatershed, OWTS and HSTS are the main methods of sanitary treatment. As this subwatershed is mostly composed of crop fields and woodlots, illicit cross-connections between OWTS and agricultural drain tiles are likely. Grandfathered or illicit off-site discharging OWTS, failing on-lot OWTS, and illicit OWTS connections to drain tiles likely contribute TP and TSS loads.

F-2.4.3.2 Livestock Operations

No CAFOs or CAFFS are in this subwatershed. The single CFO in the subwatershed is Long Lane Farms Incorporated, which raises hogs (see Figure C-8 and Table C-14 in Appendix C).The CFO drains to the unnamed tributary to Fish Creek, specifically to segment INA0346_T1003 that is listed for IBC. Aerial imagery shows structures for housing the hogs, containment ponds, and a pivot irrigation system. Indiana Department of Natural Resources (IDNR 2015) records indicate that an 8-inch diameter, 85-foot deep well is used to withdraw water for irrigation purposes on this property. Manure from this facility may be land-applied to cropland owned by the CFO or nearby farms. Given the small size of this facility, its central location in this subwatershed, and the proximity of the Ohio-Indiana state border, it less likely that manure from the CFO is transported out of this subwatershed for land application.

Within *Fish Creek* (HUC 0410003 04), SJRWI (2008a) observed livestock during windshield surveys at 14 locations in Ohio, at 76 locations in Steuben County, Indiana, and 50 locations in DeKalb County,

[9] No industrial or public facilities with individual or general NPDES permits, biosolids application fields, communities with CSOs or SSOs, or regulated MS4s are in this subwatershed.

Indiana; no livestock direct access to streams was observed and manure storage was observed at two locations in DeKalb County. Thus, livestock in Indiana and Ohio may contribute nutrients or sediment that impair biotic communities.

F-2.4.3.3 Crop Production

As shown in Figure F-10, cropland is the dominant source of TP and TSS loading in the TMDL subwatershed. Most of this subwatershed is agricultural land, with woodlots along Fish Creek and some of its tributaries. An analysis of aerial imagery shows that, with the exception of Fish Creek, streams throughout this subwatershed are channelized and straightened, especially when flowing through crop fields. Many streams have very thin forested riparian buffers or are without buffers.

F-2.5 Big Run (HUC 04100003 05 02)

Big Run flows easterly and is mostly in Indiana. The subwatershed includes many named tributaries (e.g., Donnell, John Smith, King, and Mary Metcalf ditches). While most of the subwatershed is rural and agricultural, the city of Butler is mostly in the Big Run subwatershed. U.S. route 6 and railroad lines bisect the subwatershed. As with much of the SJRW, forested woodlots are throughout the subwatershed.

F-2.5.1 Monitoring Data

Samples collected by IDEM and SJRWI in Indiana are discussed in Section F-2.5.1.1 and Section F-2.5.1.2 (respectively), while samples collected by Ohio EPA in Ohio are discussed in Section F-2.5.1.3. IDEM listed two segments of the Big Run (INA0352_04 and INA0352_05) for IBC. Such listings are addressed via TP and TSS TMDLs when one or both parameters exceeds its target. Since neither TP results nor TSS results exceed targets, TMDLs were not developed to address IBC listings on Big Run.

F-2.5.1.1 IDEM

IDEM collected water chemistry samples at two sites on the Big Run. Site LEJ060-015 is on segment INA0352_04, and site LEJ060-008 is on segment INA0352_05. As shown in Table F-1, TP and TSS concentrations from all three samples collected at site LEJ060-0015 were below targets. Samples at site LEJ060-0008 were not evaluated for TP or TSS.

F-2.5.1.2 SJRWI

SJRWI sampled site 127 that is just east of IDEM site LEJ060-0008; while TP concentrations varied over a considerable range (Table F-2) about 40 percent of samples were non-detects.

F-2.5.1.3 Ohio EPA

Ohio EPA sampled site P08K08 at the confluence of Big Creek with the SJR. One of six samples collected in 2013 yielded a TP concentration (0.46 mg/L on 7/8/2013) above the Indiana (0.30 mg/L) and Ohio (0.08 mg/L; wading WWH) TP targets. Four of six TSS samples were non-detect; one sample (236 mg/L on 7/8/2013) was above the Indiana (30 mg/L) and Ohio (29 mg/L) targets.

Site P08K08 was in full attainment of its WWH ALU and Ohio EPA did not list this WAU as impaired for its ALU.

F-2.5.2 Load Duration Curve

Since no TP or TSS sample results exceeded targets, no LDCs nor TMDLs were developed.

F-2.5.3 Sources of Impairment

Nutrient and sediment sources were not assessed because these pollutants are not the cause of impairment. During the development of the point sources inventory, a few permitted point sources were identified in this subwatershed[10].

F-2.5.3.1 Public Facility with an Individual NPDES Permit[11]

One public facility is covered by an individual NPDES permit: Butler WWTP (IN0022462; see Figures C-3 and C-4 in Appendix C for maps and Table F-3 and Table F-4for DMR data). The facility is a 2 mgd sanitary POTW that discharges to Big Run. The city has one CSO outfall on Big Run (003) that discharged in 2008 through 2014 (Table C-6 in Appendix C).

F-2.5.3.2 Facilities Covered by General NPDES Permits

Five entities are covered by general NPDES permits. Eastside High School (ING250077) discharges NCCW to Butler's storm sewers that drain to Big Run. Three industrial facilities hold general NPDES permit coverage for industrial stormwater (INRM00985, INRM01605, and INRM01734 in Table C-3), while one construction site held coverage for stormwater.

F-2.5.3.3 On-Site Wastewater Treatment Systems

Except for the city of Butler, this subwatershed is served by OWTS. Grandfathered or illicit off-site discharging OWTS, failing on-lot OWTS, and illicit OWTS connections to drain tiles likely contribute TP and TSS loads.

F-2.5.3.4 Livestock Operations

No CAFFs are in the Ohio-portion of the subwatershed and one CAFO is in the Indiana-portion of the subwatershed (see Figure C-6 and Table C-11). The Irish Acres Dairy, LLC, is a CAFO with 1,196 dairy cattle. The CAFO drains to Haverstock Ditch, which is tributary to Big Run. Aerial imagery shows that the CAFO has containment ponds. Untreated livestock wastewater may not be discharged to surface streams but is a potential source of impairment during larger precipitation events that cause overland flow and runoff.

F-2.6 Cedar Lake-Cedar Creek (HUC04100003 06 01)

Cedar Creek begins at the outflow of Cedar Lake in DeKalb County. The main tributary to Cedar Lake is Leins Ditch. About half of the Leins Ditch subwatershed is drained by McCullough Ditch that beings at the outlet of Indian Lake. Besides numerous small lakes and woodlots (including a few large woodlots in the headwaters) the land cover is predominantly agricultural. A small portion of the lower subwatershed includes industrial and commercial development, which is the outskirts of the town of Waterloo (e.g., Techo Bloc quarry and manufacturing facility). The U.S. Route 6 interchange with Interstate 69 is just upstream of the outlet of the subwatershed.

F-2.6.1 Monitoring Data

IDEM sampled one location each on Indian Lake (LEJ080-0012), Leins Ditch (LEJ080-0016), Cedar Creek (LEJ080-0015), and an unnamed tributary to Leins Ditch (LEJ080-0014). Just downstream of this subwatershed, IDEM also sampled Cedar Creek (LEJ080-0011); however, TP and TSS data were not collected at this site. Neither TP nor TSS exceeded targets at sites LEJ080-0016 or LEJ080-0014. Of the 39 samples collected at site LEJ080-0005 (Table F-1), one TP sample (3 percent) and 10 TSS samples (26 percent) exceeded targets.

[10] No industrial facilities with individual NPDES permits, no biosolids application fields, or regulated MS4s are in this subwatershed.

[11] The following four permits were terminated: Citation Bohn Aluminum (IN0000515; NCCW and stormwater), DeKalb County East Community School District (IN0055808), DeKalb Molded Plastics Company (IN0051659), and Universal Tool and Stamping Company (IN0000639; rinse water).

IDEM listed two segments of Cedar Creek (INA0361_03 and INA0361_04) for nutrients. As TP occasionally exceed targets, the nutrient listing was addressed through the development of a TP TMDL at the outlet of the subwatershed.

F-2.6.2 Load Duration Curve

A LDC was developed for Cedar Creek (Figure F-11). No TP data were collected near the HU outlet by IDEM in 2004-2014. Exceedances of the LDC only occurred in the high flow and moist conditions flow zones. However, the majority of SWAT-simulated TP loads in each of these flow zones was less than the LDC.

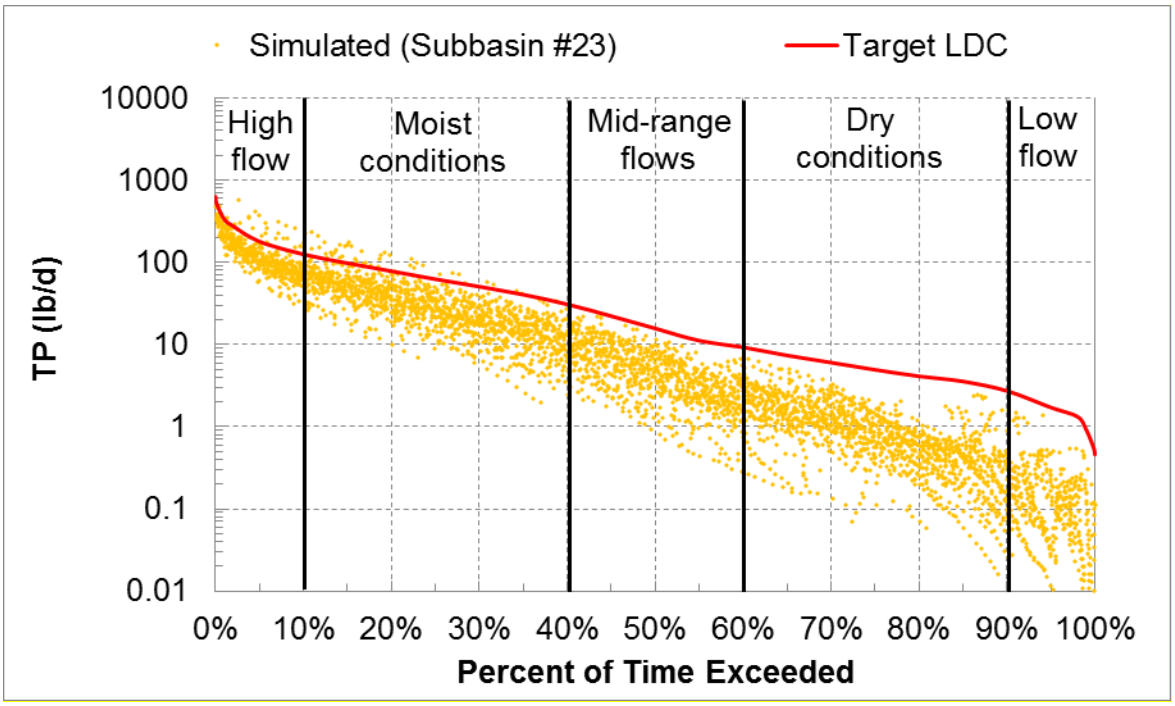
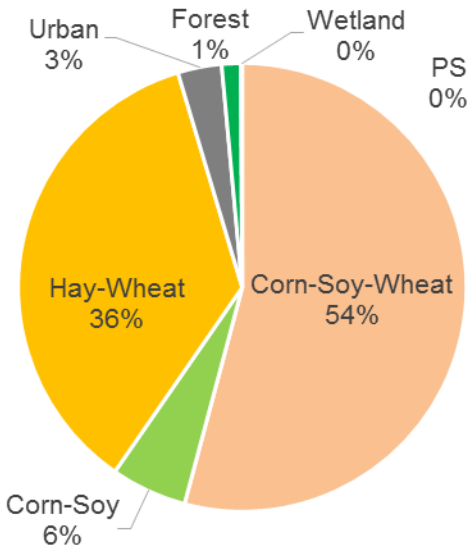


Figure F-11. TP LDC for Cedar Creek in *Cedar Lake-Cedar Creek* (*06 01) at the HU outlet.

F-2.6.3 Sources of Impairment

SWAT-simulated source loads[12] indicate that crops are the dominant source of TP load to Cedar Creek in this HU (Figure F-12).

[12] SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) within a single model subbasin. These loads also include model inputs from certain point sources (e.g., WWTPs). Such loads are inputs to the model reaches and do not account for in-stream processes. These loads are plotted as annual average loads across the 11-year SWAT model simulation period. As the TMDL subwatersheds are composed of multiple model subbasins, the results per subbasin are summed.



Notes
Relative loads are rounded to the nearest percentage point.
No point sources were simulated.
SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) and the loads derived from model inputs for certain point sources. Such loads are inputs to the model reaches and do not account for in-stream processes. Results are summarized as the 11-year average of annual loads by source category.

Figure F-12. Summary of SWAT-simulated annual TP loads that drain to Cedar Creek at the outlet of *Cedar Lake-Cedar Creek* (*06 01).

The potential sources of nutrients in this HU are evaluated in the following sections.[13]

F-2.6.3.1 Facilities Covered by a General NPDES Permit

Benchmark Distribution Terminals (ING340037) is covered by Indiana's general permit for petroleum distribution terminals; the facility is permitted to discharge industrial stormwater. Additionally, three industrial facilities hold general NPDES permit coverage for industrial stormwater (INRM00244, INRM00941, and INRM01759 in Table C-3), while two construction site held coverage for stormwater.

F-2.6.3.2 On-Site Wastewater Treatment Systems

As no publicly owned treatment works (POTWs) are in this subwatershed, OWTS and HSTS are the main methods of sanitary treatment. As this subwatershed is mostly composed of crop fields and woodlots, illicit cross-connections between OWTS and agricultural drain tiles are likely. Grandfathered or illicit off-site discharging OWTS, failing on-lot OWTS, and illicit OWTS connections to drain tiles likely contribute TP and TSS loads.

F-2.6.3.3 Unregulated Livestock Operations

No CAFOs or CFOs are in this subwatershed. No information about hobby farms and small livestock operations are available but such operations are likely present throughout the subwatershed. Within *Cedar Lake-Cedar Creek* (*06 01), SJRWI (2008a) observed livestock during windshield surveys at 62 locations; no manure storage or livestock with direct access to streams were observed. Between 1 and 12 animals were observed at 52 locations, 15 to 20 animals were observed at nine locations, and 200 sheep

[13] No industrial or public facilities with individual NPDES permits, CAFOs or CFOs, communities with CSOs or SSOs, or regulated MS4s are in this subwatershed. Marathon Oil (ING340018; steam condensate hydrostatic test waters) was physically located in *Dibbling Ditch-Cedar Creek* (HUC 04100003 06 02) but formerly discharged through outfall 001 in this subwatershed; the permit was later terminated.

were observed at one location. No additional information about hobby farms and small livestock operations are available. Thus, livestock may contribute nutrient loads to the impairment.

F-2.6.3.4 Crop Production

As shown in Figure F-12, cropland is the dominant source of TP loading in the TMDL subwatershed. Most of this subwatershed is agricultural land. An analysis of aerial imagery shows that streams throughout this subwatershed are channelized and straightened, especially when flowing through crop fields. Many streams have very thin forested riparian buffers or are without buffers.

No septage land application is permitted in this subwatershed. Application of biosolids from the Auburn WWTP was permitted on one field (CLU-SO6; 15 acres) in the lower subwatershed; no information on any actual applications is available. Manure application likely occurs on farms; the sources of such manure are small livestock operations. No application date, volume, or rate data are available; thus, the significance of manure application cannot be determined.

F-2.7 Dibbling Ditch-Cedar Creek (HUC 04100003 06 02)

This subwatershed is composed of a short segment of Cedar Creek from the confluence of Dibbling Ditch to the confluence with Mason Ditch. Most the subwatershed drains to two tributaries of Cedar Creek: Dibbling Ditch and Schwartz Ditch. The Dibbling Ditch subwatershed is almost all rural, agricultural but does include the outskirts of the town of Ashley (to the north of this HU). The Schwartz Ditch subwatershed is also rural and agricultural. Cedar Creek flows along the perimeter of the town of Waterloo.

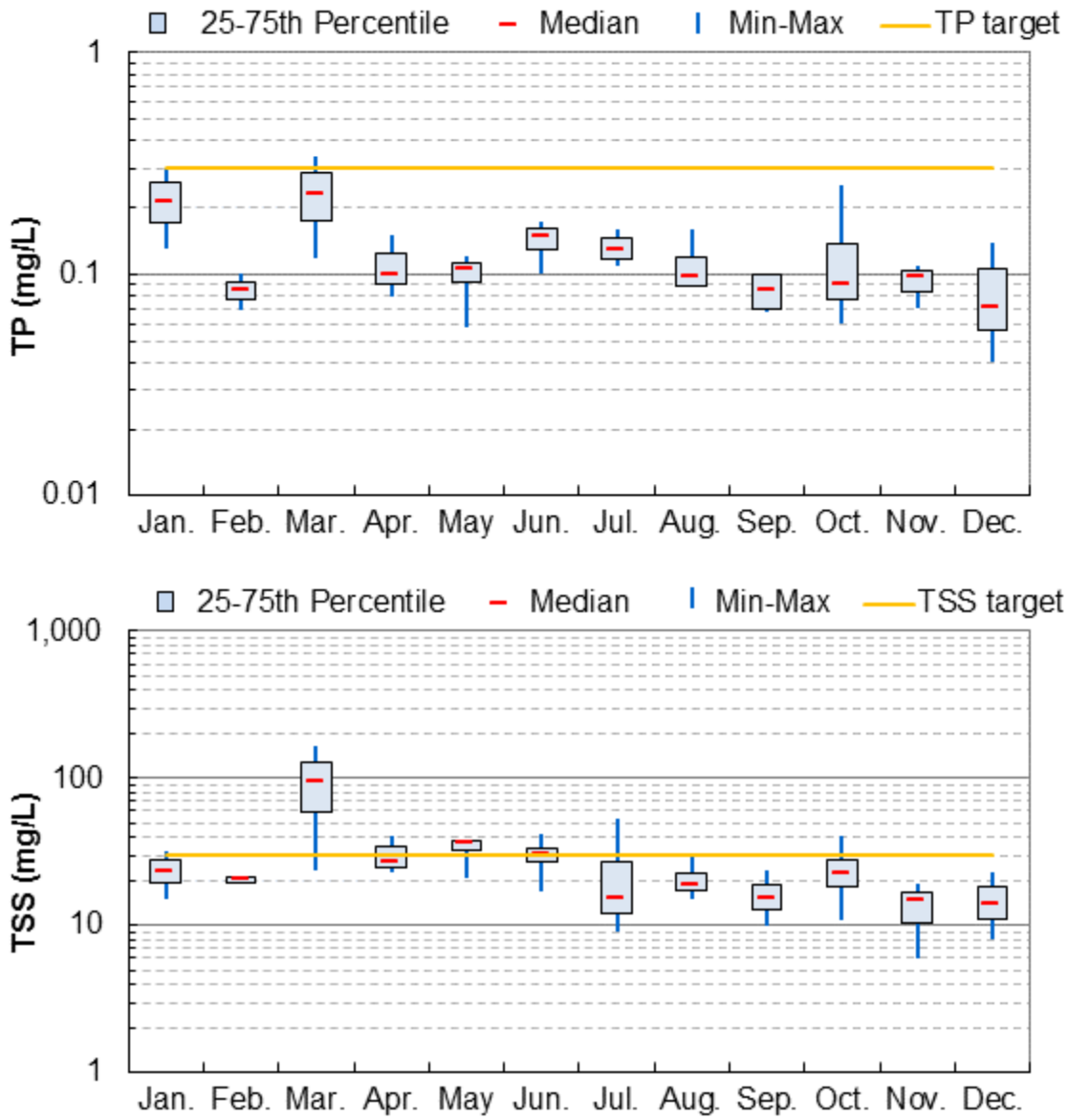
F-2.7.1 Monitoring Data

Samples were collected by IDEM (Section F-2.7.1.1) and SJRWI (Section F-2.7.1.2). IDEM listed four segments of Cedar Creek (INA0362_02, INA0362_03, INA0362_04, and INA0363_03) as impaired by nutrients. The nutrient listing was addressed through the development of a TP TMDL at the outlet of the HU.

F-2.7.1.1 IDEM

IDEM sampled three sites on Cedar Creek (LEJ080-0005, LEJ080-0006, and LEJ080-0011) and one site on Schwartz Ditch (LEJ080-0008). In 2000, five samples were collected from sites LEJ080-0006 and LEJ080-0008 and three samples were collected from site LEJ080-0011. No samples were evaluated for TP. Chlorophyll-*a* was evaluated at site LEJ080-0008 (3.4 to 40.2 µg/L) and site LEJ080-0008 (1.4 to 17.2 µg/L). DO was evaluated at sites LEJ080-0006 (7.69 to 13.56 mg/L) and LEJ080-0011 (6.89 to 9.64 mg/L) on Cedar Creek and site LEJ080-0008 (5.96 to 13.94 mg/L) on Schwartz Ditch.

Long-term data collected at site LEJ080-0005 are summarized in Figure F-13. TP and TSS increase in late spring and decrease in the summer and fall.



Note: 39 samples collected 2013-2014.

Figure F-13. TP (top) and TSS (bottom) at site LEJ080-0005 on Cedar Creek.

F-2.7.1.2 SJRWI

SJRWI sampled Cedar Creek (site 116), Dibbling Ditch (sites 115 and 143), and Schwartz Ditch (site 142). Samples collected in 2008 through 2010 and 2013 at sites 142 and 143 were evaluated for TP (Table F-2). TP results exceed at both sites 142 (14 of 175 results; 8 percent) and 143 (12 of 115 results; 10 percent).

F-2.7.2 Load Duration Curve

A LDC was developed for Cedar Creek (Figure F-14). No TP data were collected near the HU outlet by IDEM in 2004-2014. Exceedances of the LDC only occurred in the high flow and moist conditions flow

zones. However, the majority of SWAT-simulated TP loads in each of these flow zones was less than the LDC.

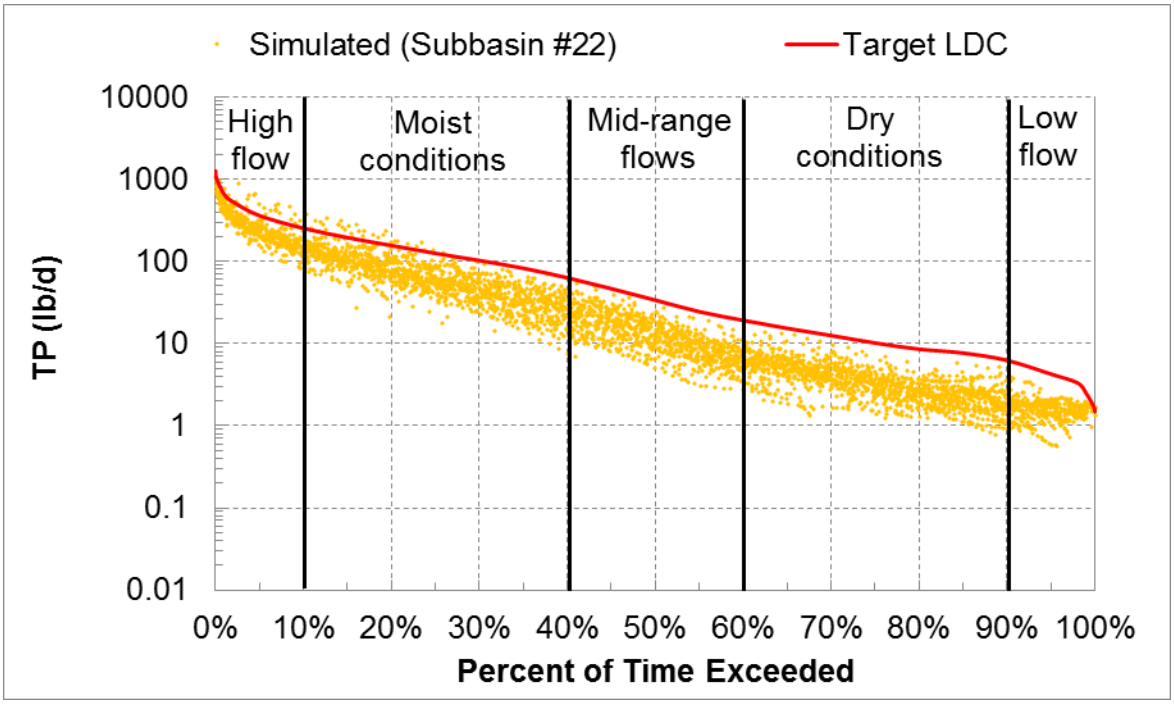
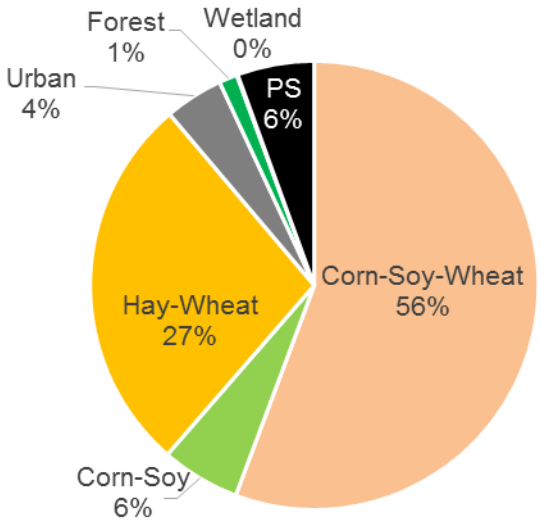


Figure F-14. TP LDC for Cedar Creek in *Dibbling Ditch-Cedar Creek* (*06 02) at the HU outlet.

F-2.7.3 Sources of Impairment

SWAT-simulated source loads[14] indicate that crops are the dominant source of TP load to Cedar Creek in this HU (Figure F-15). One-half of the TP source load at the mouth of this HU is derived from this HU while the other one-half of the load is derived from *Cedar Lake-Cedar Creek* (*06 01).

[14] SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) within a single model subbasin. These loads also include model inputs from certain point sources (e.g., WWTPs). Such loads are inputs to the model reaches and do not account for in-stream processes. These loads are plotted as annual average loads across the 11-year SWAT model simulation period. As the TMDL subwatersheds are composed of multiple model subbasins, the results per subbasin are summed.



Notes
"PS" = permitted point sources.
Relative loads are rounded to the nearest percentage point.
SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) and the loads derived from model inputs for certain point sources. Such loads are inputs to the model reaches and do not account for in-stream processes. Results are summarized as the 11-year average of annual loads by source category.

Figure F-15. Summary of SWAT-simulated annual TP loads that drain to Cedar Creek at the outlet of *Dibbling Ditch-Cedar Creek* (*06 02).

The potential sources of nutrients in this HU are evaluated in the following sections.[15]

F-2.7.3.1 Public Facilities with Individual NPDES Permits

Two public facilities are covered by individual NPDES permits[16] (see Figures C-3 and C-4 for maps and Table F-3 for DMR data).

- **Waterloo Municipal STP** (IN0020711; 240,000 gpd) is a sanitary POTW that discharges to the Cedar Creek. Effluent volumes were fairly consistent (0.2 to 1.1 cfs, average 0.5 cfs), while TP concentrations (0.2 to 1.3 mg/L, average 0.6 mg/L) and loads (0.3 to 18.9 lbd/s, average 1.6 lbs/d) were often high. Based upon SWAT-simulated TP loads, in-stream TP loads are typically considerably larger than effluent loads; only during in-stream low flow conditions could effluent loads become a dominant portion of the in-stream load.
- **Waterloo Public Water Supply** (IN0049433) was a WTP that formerly discharged to a county drain tributary to Cedar Creek. As the WTP should not discharge TP and its effluent volumes were very small, the WTP was not a source of nutrient impairment.

F-2.7.3.2 Facilities Covered by General NPDES Permits

Benchmark Distribution Terminals (ING340037) is covered by Indiana's general permit for petroleum distribution terminals; the facility is permitted to discharge industrial stormwater. Two industrial facilities hold general NPDES permit coverage for industrial stormwater (INRM00184 and INRM00487 in Table C-3). Four construction site in the headwaters of the Dibbling Ditch subwatershed (near the town of

[15] No industrial or public facilities with individual NPDES permits, communities with CSOs or SSOs, or regulated MS4s are in this subwatershed.
[16] Marathon Oil (ING340018; steam condensate hydrostatic test waters) was formerly permitted to discharge in this HU.

Ashley) and three construction sites between Cedar Creek and Schwartz Ditch held coverage for stormwater.

F-2.7.3.3 On-Site Wastewater Treatment Systems

Outside of the town of Waterloo, OWTS are the main methods of sanitary treatment. As this subwatershed is mostly composed of crop fields and woodlots, illicit cross-connections between OWTS and agricultural drain tiles are likely. Grandfathered or illicit off-site discharging OWTS, failing on-lot OWTS, and illicit OWTS connections to drain tiles likely contribute TP and TSS loads.

F-2.7.3.4 Livestock Operations

Only one permitted livestock operation is in this HU; Phillips Farm is a CAFO with dairy calves and dairy heifers (see Figure C-8 and Table C-14 in Appendix C). The CAFO drains to Schwartz Ditch. Aerial imagery shows structures for housing the cattle and man-made containment ponds. Manure from this facility may be land-applied to cropland owned by the CAFO or nearby farms. As the town of Waterloo is to the east and two HUs are 0.5 mile north and south of the CAFO, it is feasible that manure is transported outside of the HU for land application.

Within the TMDL subwatershed, SJRWI (2008a) observed livestock during windshield surveys at 98 locations; no manure storage or livestock with direct access to streams were observed. Between 1 and 9 animals were observed at 70 locations; 10 to 25 animals, 18 locations; 30 to 40 animals, 4 locations; and 100-200 animals, five locations. No additional information about hobby farms and small livestock operations are available. Thus, livestock may contribute nutrients loads that impair this HU.

F-2.7.3.5 Crop Production

As shown in Figure F-15, cropland is the dominant source of TP loading in the TMDL subwatershed. Except along Cedar Creek that flows around the town of Waterloo, most of this subwatershed is agricultural land. An analysis of aerial imagery shows that streams throughout this subwatershed are channelized without forested riparian buffers.

No septage land application is permitted in this subwatershed. Application of biosolids from the following facilities was permitted (Table C-11):

- Auburn WWTP (8 fields; over 100 acres; incorporation, injections, and surficial; 1992-1993)
- Kendallville Municipal STP (1 field; 2 acres of corn; injection in 1999)
- Waterloo STP (7 fields; over 100 acres of corn and soybean; injections 1989-1999)

Manure application likely occurs on farms; the sources of such manure are small livestock operations. No application date, volume, or rate data are available; thus, the significance of manure application cannot be determined.

F-2.8 Matson Ditch-Cedar Creek (HUC 04100003 06 03)

The Matson Ditch subwatershed is predominantly rural and agricultural. Residential properties are at a higher density in the lower reaches of the subwatershed in areas closer to the town of Waterloo. The unnamed tributary to Matson Ditch meanders through crop fields and woodlots, with no forested riparian buffers along the segments flowing through crop fields. The unnamed tributary pass through culverts under state route 427 and county roads 16 and 51; it then flows in a straightened channel parallel to country road 51 until its confluence with Matson Ditch.

F-2.8.1 Monitoring Data

Samples were collected by IDEM (Section F-2.8.1.1) and SJRWI (Section F-2.8.1.2). IDEM listed the unnamed tributary to Matson Ditch (INA0363_T1001) as impaired by nutrients. The nutrient listing was addressed through the development of a TP TMDL at the confluence of the unnamed tributary to Matson Ditch with Matson Ditch.

F-2.8.1.1 IDEM

IDEM sampled one location on the unnamed tributary to Matson Ditch (LEJ080-0013; Table F-1) in 2005. One of the three samples evaluated for TP exceeded the TP target. These three samples were also evaluated for ash-free dry mass (171.7 to 241.6 grams per square meter), periphyton chlorophyll-*a* (35.5 to 357.8 milligrams per square meter), and seston chlorophyll-a (1.78 to 3.58 µg/L). Finally, DO was evaluated on 11 occasions (4.78 to 8.94 mg/L, median 6.05 mg/L)

F-2.8.1.2 SJRWI

SJRWI sampled one location at the mouth of Matson Ditch on Cedar Creek (106; Table F-2). Of the 329 samples collected from 2002 through 2013, 40 samples (12 percent) exceed the TP target.

F-2.8.2 Load Duration Curve

An LDC was developed for the unnamed tributary to Matson Ditch (Figure F-16) and TP data collected by IDEM in 2005 are displayed as loads[17]. An exceedance of the LDC occurred in the dry conditions zone. To achieve the TMDL (i.e., reduce load to the LDC), a 17 percent reduction is necessary.

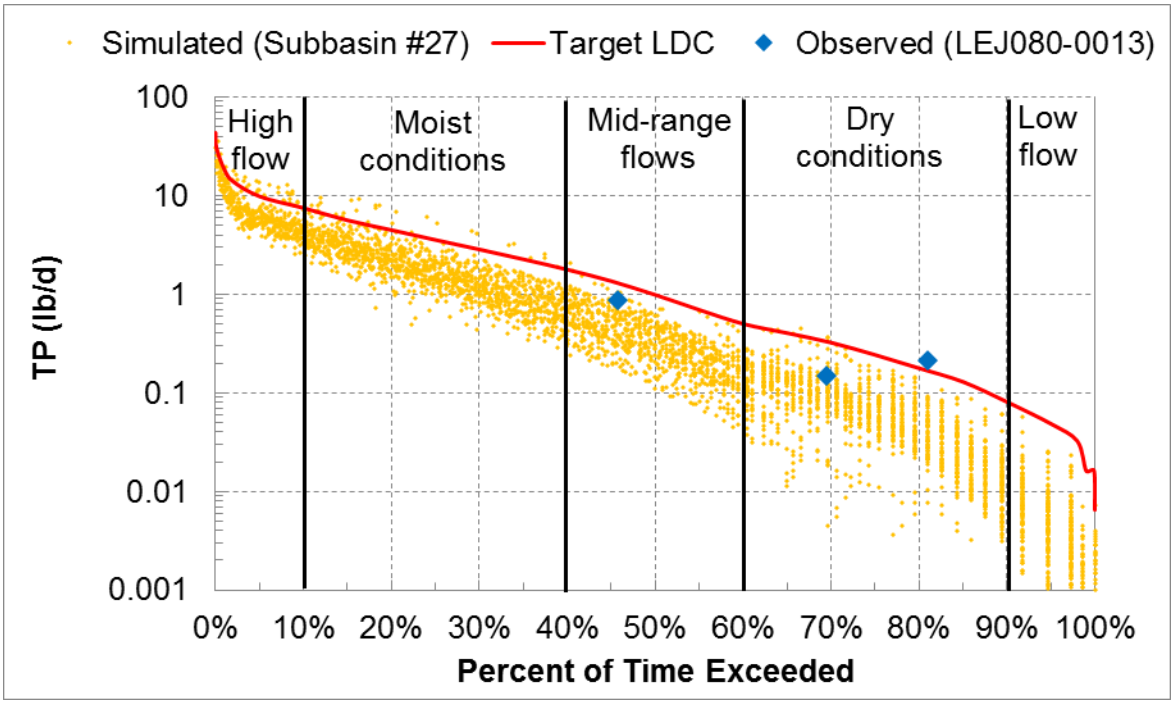
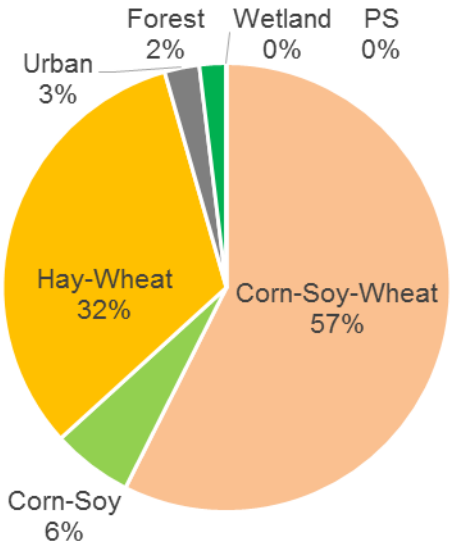


Figure F-16. TP loads and LDC for the unnamed tributary to Matson Ditch in *Matson Ditch-Cedar Creek* (*06 03) at the confluence of the unnamed tributary with Matson Ditch.

[17] TP concentrations from IDEM samples were multiplied by SWAT-simulated flows and converted to appropriate units.

F-2.8.3 Sources of Impairment

SWAT-simulated source loads[18] indicate that crops are the dominant source of TP load to the unnamed tributary of Matson Ditch in this HU (Figure F-10).



Notes
Relative loads are rounded to the nearest percentage point.
No point sources or wetlands were simulated.
SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) and the loads derived from model inputs for certain point sources. Such loads are inputs to the model reaches and do not account for in-stream processes. Results are summarized as the 11-year average of annual loads by source category.

Figure F-17. Summary of SWAT-simulated annual TP loads that drain to the unnamed tributary to Matson Ditch at the confluence with Matson Ditch of *Matson Ditch-Cedar Creek* (*06 03).

The potential sources of nutrients and sediment in this HU are evaluated in the following sections.[19]

F-2.8.3.1 On-Site Wastewater Treatment Systems

The unnamed tributary to Matson Ditch subwatershed includes about a dozen residences that are assumed to use OWTS. As this subwatershed is mostly composed of crop fields, illicit cross-connections between OWTS and agricultural drain tiles are likely. Grandfathered or illicit off-site discharging OWTS, failing on-lot OWTS, and illicit OWTS connections to drain tiles likely contribute TP and TSS loads.

F-2.8.3.2 Unregulated Livestock Operations

No CAFOs or CFOs are in this subwatershed. An analysis of aerial imagery is inconclusive but hobby farms appear to be present. Within the TMDL subwatershed, SJRWI (2008a) observed livestock during windshield surveys at two locations; no manure storage or livestock with direct access to streams were

[18] SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) within a single model subbasin. These loads also include model inputs from certain point sources (e.g., WWTPs). Such loads are inputs to the model reaches and do not account for in-stream processes. These loads are plotted as annual average loads across the 11-year SWAT model simulation period. As the TMDL subwatersheds are composed of multiple model subbasins, the results per subbasin are summed.

[19] No industrial or public facilities with individual or general NPDES permits, CAFOs or CFOs, communities with CSOs or SSOs, or regulated MS4s are in this subwatershed.

observed. No additional information about hobby farms and small livestock operations are available. Thus, livestock may contribute nutrients loads that impair this HU.

F-2.8.3.3 Crop Production

As shown in Figure F-17, cropland is the dominant source of TP loading in the TMDL subwatershed. This subwatershed is composed of about a dozen residences, each adjacent to row crop operations, and a few woodlots. Agricultural runoff is likely the source of any pollutants because the vast majority of land in this subwatershed is under cultivation.

F-2.9 Smith Ditch-Cedar Creek (HUC 04100003 06 04)

This subwatershed is composed of a Cedar Creek from the confluence of Matson Ditch to the confluence with John Diehl Ditch. Three tributaries in this HU drain to Cedar Creek: Smith Ditch, Metcalf Ditch, and an unnamed tributary. The Smith Ditch subwatershed, upstream of the unnamed tributary to Smith Ditch (INA0364_T1003), is rural and agricultural. Smith Ditch and its unnamed tributary are channelized and straightened without forested riparian buffers. The lower reaches of Smith Ditch (INA0364_T1002) flow through the city of Auburn.

F-2.9.1 Monitoring Data

Samples were collected by IDEM (Section F-2.9.1.1) and SJRWI (Section F-2.9.1.2). IDEM listed one segment of Smith Ditch (INA0364_T1001) for IBC. Such listings are addressed via TP and TSS TMDLs when one or both parameters exceeds its target. Since neither TP results nor TSS results exceed targets, TMDLs were not developed to address IBC listings on Smith Ditch.

F-2.9.1.1 IDEM

IDEM collected water chemistry samples from Cedar Creek (LEJ080-0004, LEJ080-0007, LEJ080-0009, and LEJ080-0010), and Smith Ditch (LEJ080-0017). None of the Cedar Creek samples were evaluated for TP or TSS. Three samples were collected in 2010 from Smith Creek; none exceeded the TP or TSS targets (Table F-1).

F-2.9.1.2 SJRWI

SJRWI collected water chemistry samples from Cedar Creek (105) and Smith Ditch (141). Cedar Creek was sampled downstream of the confluence with Smith Ditch in 2014, and two of 29 samples (7 percent) exceeded the TP target. Smith Ditch was sampled in 2002 through 2014, and 50 of 317 samples (16 percent) exceeded the TP target.

F-2.9.2 Load Duration Curve

Since no TP or TSS sample results exceeded targets, no LDCs nor TMDLs were developed.

F-2.9.3 Sources of Impairment

Nutrient and sediment sources were not assessed because these pollutants are not the cause of impairment. During the development of the point sources inventory, only three permitted point sources were identified in the Smith Ditch subwatershed[20]: three construction sites were permitted for stormwater discharge. None of the permitted construction sites drained to the impaired segment of Smith Ditch.

[20] No public or private facilities with individual NPDES permits, CAFOs or CFOs , communities with CSOs or SSOs, or regulated MS4s are in this subwatershed.

F-2.10 Peckhart Ditch-John Diehl Ditch (HUC 04100003 07 02)

This HU is composed of the John Diehl Ditch from the confluence of Peckart Ditch to the confluence with Cedar Creek. Much of the HU is composed of the Peckart Ditch subwatershed, while most of the John Diehl Ditch subwatershed is contained in the *Headwaters John Diel Hitch* HU (HUC 041000003 07 01). The largest tributary to Peckhart Ditch is Ober Ditch.

The Peckhart Ditch subwatershed is predominantly rural and agricultural. The headwaters of the Ober Ditch subwatershed include much of the town of Corunna, while the lower reaches of Peckhart Ditch are in commercial development (e.g., movie theater, hardware store) within the outskirts of the city of Auburn. Peckhart Ditch flows beneath Interstate 69 just before its confluence with John Diehl Ditch.

F-2.10.1 Monitoring Data

Samples were collected by IDEM (Section F-2.10.1.1) and SJRWI (Section F-2.10.1.2). IDEM listed one segment of Peckhart Ditch (INA0364_T1001) for IBC and DO. This segment begins at the confluence of Ober Ditch and ends at the confluence with John Diehl Ditch. IBC listings are addressed via TP and TSS TMDLs when one or both parameters exceeds its target. As TP and TSS both occasionally exceed targets, the IBC listings were addressed through the development of TP and TSS TMDLs at the mouth of Peckhart Ditch.

F-2.10.1.1 IDEM

IDEM collected water chemistry samples from John Diehl Ditch (LEJ090-0018) and from Peckhart Ditch above (LEJ090-0040) and below (LEJ090-0034) Ober Ditch (Table F-1). TP and TSS were not evaluated in samples collected from John Diehl Ditch (site LEJ090-0018).

Three samples were collected at site LEJ090-0040 in 2010; one sample each exceeded the TP and TSS targets. DO was monitored nine times (2.40 to 8.97 mg/L, median 6.92 mg/L). Three samples were collected from site LEJ090-0034 in 2005, no sample exceeded targets. DO was monitored eight times (4.80 to 11.80 mg/L, median 6.43 mg/L).

F-2.10.1.2 SJRWI

SJRWI collected water chemistry samples from John Diehl Ditch (104) and from Peckhart Ditch (114 and 137). Site 104 is collocated with IDEM site LEJ090-0018 and site 114 is co-located with IDEM site LEJ090-0034. John Diehl Ditch was sampled from 2002 through 2013; 25 of 326 results (8 percent) exceeded the TP target. Samples were not evaluated for TP at either site on Peckhart Ditch.

F-2.10.2 Load Duration Curve

LDCs were developed for Peckhart Ditch (Figure F-18 and

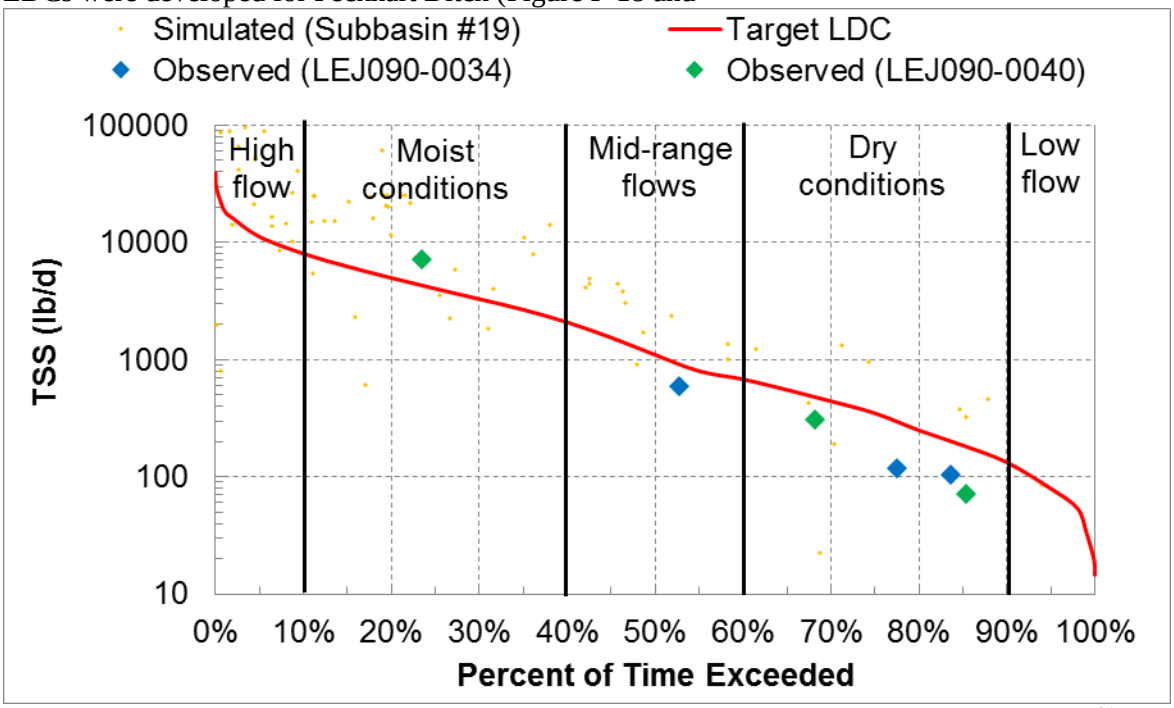
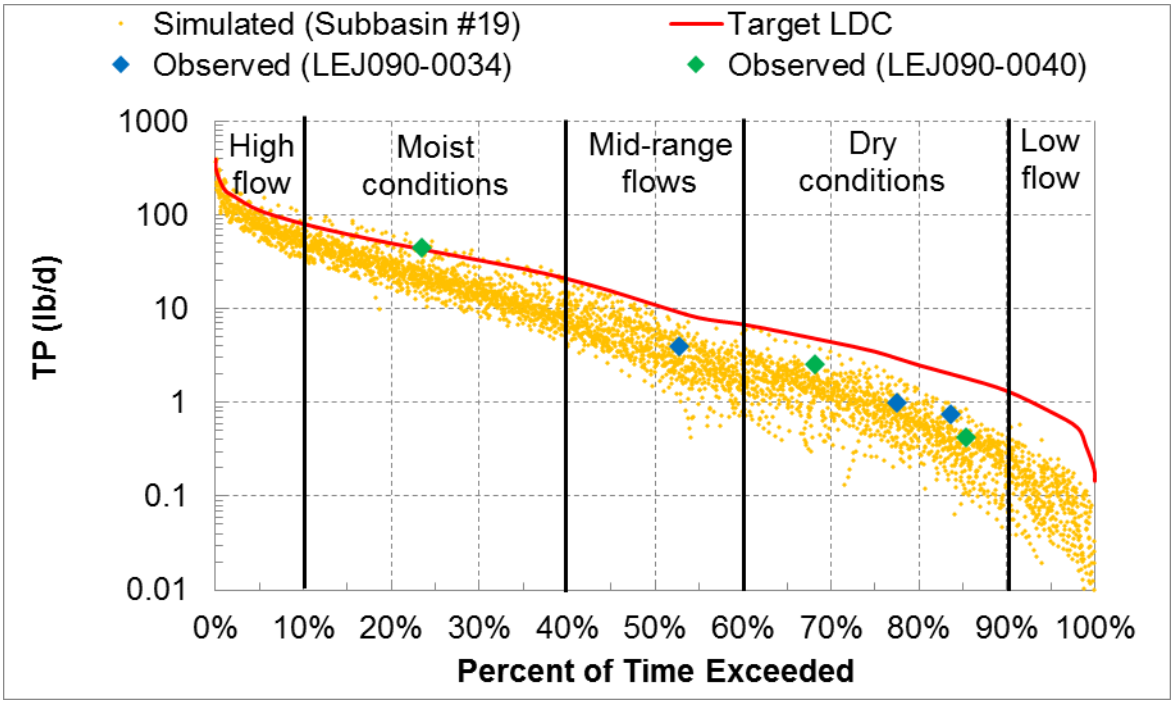


Figure F-19) and TP or TSS data collected by IDEM in 2005 and 2010 are displayed as loads[21]. Exceedances of the LDC only occurred in the moist conditions flow zones for TP and TSS. To achieve the TMDLs (i.e., reduce loads to the LDCs), reductions of 6 percent for TP and 41 percent for TSS are necessary.



[21] TP and TSS concentrations from IDEM samples were multiplied by SWAT-simulated flows and converted to appropriate units.

Figure F-18. TP loads and LDC for Peckhart Ditch in *Peckhart Ditch-John Diehl Ditch* (*07 02) at the confluence with John Diehl Ditch.

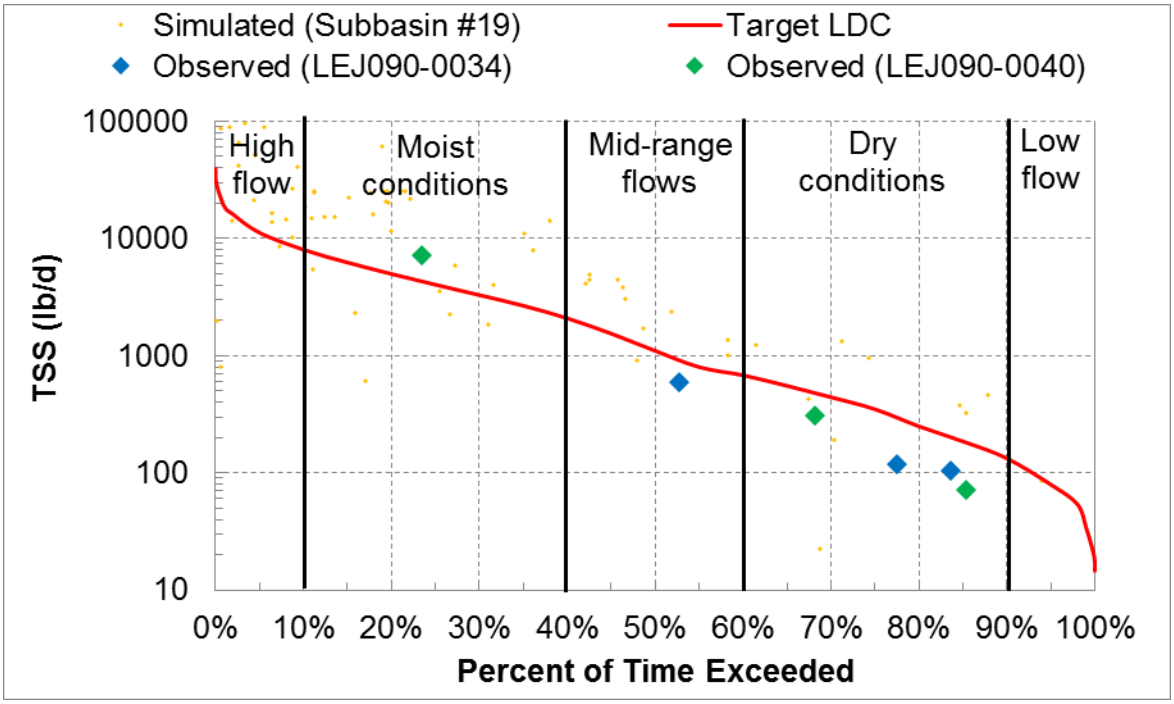
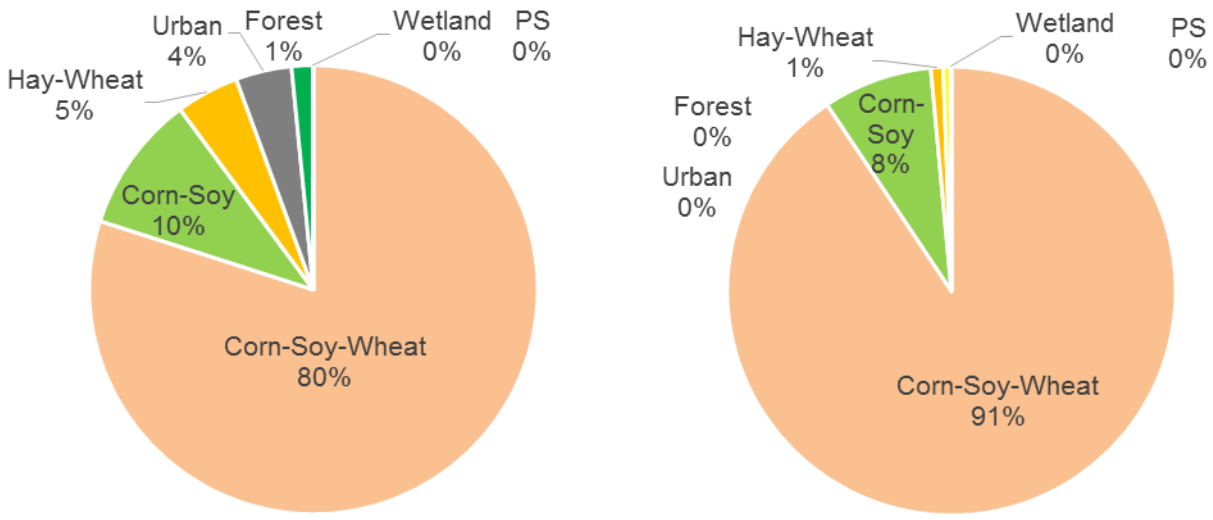


Figure F-19. TSS loads and LDC for Peckhart Ditch in Peckhart Ditch-John Diehl Ditch (*07 02) at the confluence with John Diehl Ditch.

F-2.10.3 Sources of Impairment

SWAT-simulated source loads[22] indicate that crops are the dominant source of TP and TSS load to Peckhart Ditch in this HU (Figure F-20).

[22] SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) within a single model subbasin. These loads also include model inputs from certain point sources (e.g., WWTPs). Such loads are inputs to the model reaches and do not account for in-stream processes. These loads are plotted as annual average loads across the 11-year SWAT model simulation period. As the TMDL subwatersheds are composed of multiple model subbasins, the results per subbasin are summed.



Notes
Relative loads are rounded to the nearest percentage point.
No point sources were simulated.
SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) and the loads derived from model inputs for certain point sources. Such loads are inputs to the model reaches and do not account for in-stream processes. Results are summarized as the 11-year average of annual loads by source category.

Figure F-20. Summary of SWAT-simulated annual TP (left) and TSS (right) loads that drain to Peckhart Ditch at the confluence with John Diehl Ditch of *Peckhart Ditch-John Diehl Ditch* (*07 02).

The potential sources of nutrients and sediment in this HU are evaluated in the following sections.[23]

F-2.10.3.1 Industrial Facilities with Individual NPDES Permits

A single industrial facility is covered by an individual NPDES permit (see Figures C-3 and C-4 for maps and Table F-3 for DMR data).

- **Metal Technologies** (IN0061263; 200,000 gpd)[24] is an industrial facility that discharges NCCW and industrial stormwater to Diehl Ditch. Effluent volumes varied considerably (<0.01 to 0.37 cfs, average 0.05 cfs), while maximum daily TP concentrations and loads (0.025 to >0.1 mg/L, average 0.065 mg/L; <0.16 lb/d) and TSS concentrations and loads (<1 to 37 mg/L, average 6 mg/L; <1 to 14 .b/d, average 2 lb/d) were low. This facility's NCCW is not a source of TP and TSS, and its industrial stormwater is a negligible source of these pollutants.

F-2.10.3.2 Facilities Covered by General NPDES Permits

Two industrial facilities hold general NPDES permit coverage for industrial stormwater (INRM01370 and INRM01768 in Table C-3), while five construction sites held coverage for stormwater.

F-2.10.3.3 On-Site Wastewater Treatment Systems

Residences in the northwest portion of the subwatershed are served by the Corunna WWTP (IN0047473) and residences in the southeast portion are served by the Auburn WWTP (IN0020672). The rural

[23] No public facilities with individual NPDES permits, CFOs, communities with CSOs or SSOs, or regulated MS4s are in this subwatershed.

[24] Metal Technologies (IN0061263) is located at the same address as the former Auburn Foundry Landfill (IN0061590). Adjacent grassed areas, ponds, and wetlands that are associated with Metal Technologies appear to discharge to *Dosch Ditch-Cedar Creek* (*07 07).

residences within agricultural areas along Ober and Peckhart ditches are assumed to use OWTS. Grandfathered or illicit off-site discharging OWTS, failing on-lot OWTS, and illicit OWTS connections to drain tiles likely contribute TP and TSS loads.

F-2.10.3.4 Unregulated Livestock Operations

Two permitted livestock operations are in this HU; Sunrise Heifer Farms LLC is a CAFO with dairy heifers and Haynes Dairy Farm is a CFO with finishers, nursery pigs, and sows (see Table 11 in the main report and Figure C-8 and Table C-14 in Appendix C). The CAFO drains to Peckhart Ditch with the CFO drains to Ober Ditch. Aerial imagery shows structures for housing the livestock at both facilities. Manure from this facility may be land-applied to cropland owned by the CAFO or nearby farms. As both operations are within 1.3 miles of an adjacent HU, it is feasible that manure is transported outside of the HU for land application.

Within the TMDL subwatershed, SJRWI (2008a) observed livestock during windshield surveys at 31 locations; no manure storage or livestock with direct access to streams were observed. Between 1 and 10 animals were observed at 23 locations; 15 to 60 animals, 6 locations; and 400-600 animals, two locations. None of these locations is within 2 RM of the TMDL site. No additional information about hobby farms and small livestock operations are available. Thus, livestock may contribute nutrients loads that impair this HU.

F-2.10.3.5 Crop Production

As shown in Figure F-20, cropland is the dominant source of TP loading in the TMDL subwatershed. Except for Corunna and Auburn, this subwatershed is composed of rural agriculture with many row crop operations. Agricultural runoff is likely the source of any pollutants because the vast majority of land in this subwatershed is under cultivation.

F-2.11 Black Creek (HUC 04100003 07 04)

The Black Creek subwatershed is predominantly rural and agricultural. Segments of streams and ditches throughout the subwatershed are straightened and channelized. The western half of the subwatershed drains to Bilger Ditch; most residences are adjacent to row crop fields and there are many undeveloped woodlots. Wahn Ditch is the only major tributary to Bilger Ditch. Below the confluence of Bilger Ditch with Black Creek, Black Creek flows around the town of La Otto. The lower reaches of Black Creek, as it flows due east, are bounded by wider, forested riparian buffers.

F-2.11.1 Monitoring Data

Samples were collected by IDEM (Section F-2.11.1.1) and SJRWI (Section F-2.11.1.2). IDEM listed one segment of Black Creek (INA0374_05) for IBC. This segment begins at the La Otto Regional Sewer District (RSD) WWTP and ends at the confluence of the Black Creek with Little Cedar Creek. IBC listings are addressed via TP and TSS TMDLs when one or both parameters exceeds its target. As TSS occasionally exceed the target, the IBC listing was addressed through the development of a TSS TMDL at the mouth of Black Creek on Little Cedar Creek (i.e., the outlet of the subwatershed).

F-2.11.1.1 IDEM

IDEM collected water chemistry samples from Black Creek (LEJ090-0041). Four samples were evaluated for TP and TSS. TP concentrations did not exceed the target (0.12 to 0.14 mg/L), while one TSS concentration did exceed the target (range from non-detect to 50 mg/L; Table F-1).

F-2.11.1.2 SJRWI

SJRWI collected water chemistry samples from Black Creek (sites 102, 110, and 138). TP was evaluated in 115 samples at site 102 and exceed the TP target in 8 samples (7 percent).

F-2.11.2 Load Duration Curve

A LDC was developed for Black Creek (Figure F-21) and TSS data collected by IDEM in 2010 are displayed as loads[25]. An exceedance of the LDC occurred in the low flow zones. To achieve the TMDLs (i.e., reduce loads to the LDCs), a reduction of 40 percent is necessary.

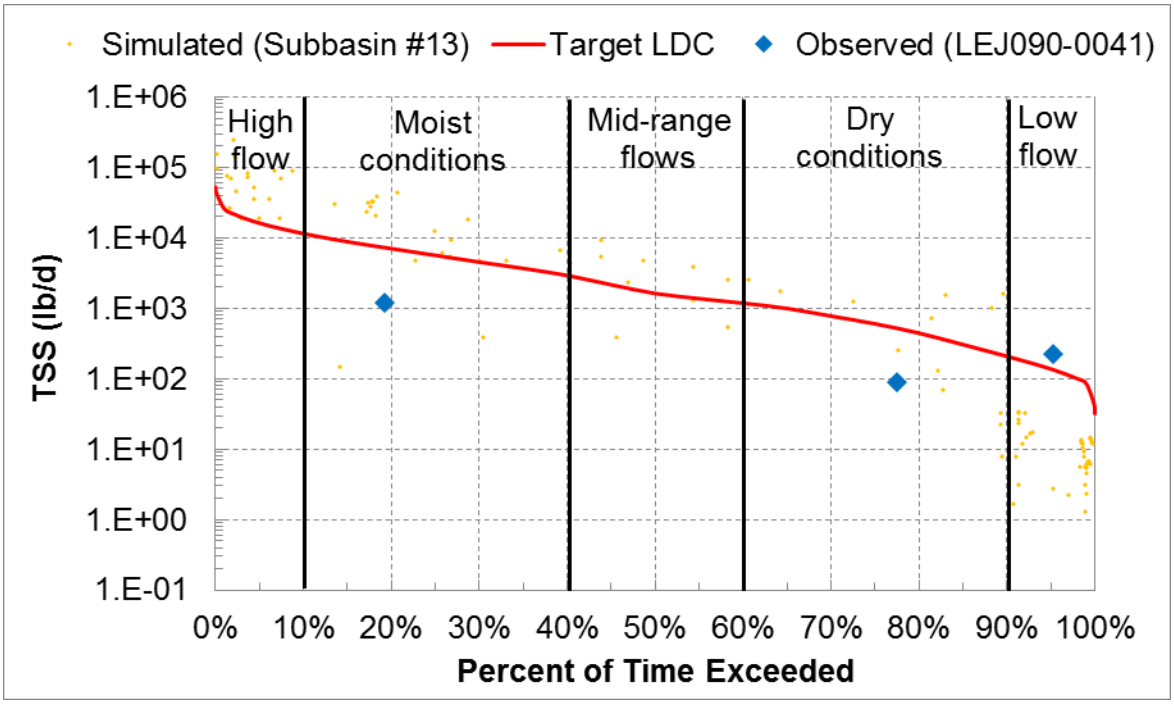


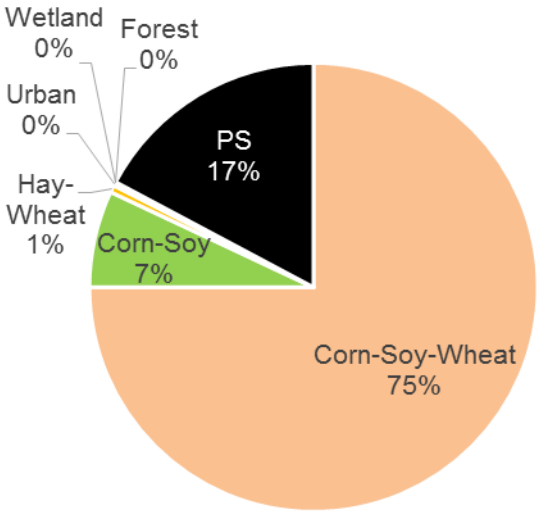
Figure F-21. TSS loads and LDC for Black Creek in *Black Creek* (*07 04) at the HU outlet.

F-2.11.3 Sources of Impairment

SWAT-simulated source loads[26] indicate that corn and soybean crops are the dominant source of TSS load to Black Creek in this HU (Figure F-10).

[25] TSS concentrations from IDEM samples were multiplied by SWAT-simulated flows and converted to appropriate units.

[26] SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) within a single model subbasin. These loads also include model inputs from certain point sources (e.g., WWTPs). Such loads are inputs to the model reaches and do not account for in-stream processes. These loads are plotted as annual average loads across the 11-year SWAT model simulation period. As the TMDL subwatersheds are composed of multiple model subbasins, the results per subbasin are summed.



Notes
"PS" = permitted point sources.
Relative loads are rounded to the nearest percentage point.
SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) and the loads derived from model inputs for certain point sources. Such loads are inputs to the model reaches and do not account for in-stream processes. Results are summarized as the 11-year average of annual loads by source category.

Figure F-22. Summary of SWAT-simulated annual TSS loads that drain to Black Creek at the outlet of *Black Creek* (*07 04).

The potential sources of nutrients in this HU are evaluated in the following sections.[27]

F-2.11.3.1 Public Facilities with Individual NPDES Permits

One public facility is covered by an individual NPDES permit[28] (see Figures C-3 and C-4 for maps and Table F-3 for DMR data).

- **La Otto RSD WWTP** (IN0058611; 50,000 gpd) is a sanitary POTW that discharges to Black Creek. Aerial imagery indicates that the lagoon facility has three cells. Effluent volumes were very low (0.002 to 0.066 cfs, average 0.035 cfs). TSS concentrations (2 to 80 mg/L, average 24 mg/L) were typically low with the occasional spike. TSS loads (<0.1 to 21 lbd/s, average 5lbs/d) were typically low. An evaluation of SWAT-simulated in-stream loads indicates that effluent loads are orders of magnitude less than in-stream loads.

F-2.11.3.2 Facilities Covered by General NPDES Permits

One construction site in the Wahn Ditch subwatershed and one construction site along the lower segment of Black Creek held stormwater permit coverage.

F-2.11.3.3 On-Site Wastewater Treatment Systems

Outside of the town of La Otto, OWTS are the main methods of sanitary treatment. As this subwatershed is mostly composed of crop fields and woodlots, illicit cross-connections between OWTS and agricultural drain tiles are likely. Grandfathered or illicit off-site discharging OWTS, failing on-lot OWTS, and illicit OWTS connections to drain tiles likely contribute TP and TSS loads.

[27] No industrial or with individual NPDES permits, communities with CSOs or SSOs, CAFOs or CFOs, biosolids application fields, or regulated MS4s are in this subwatershed.
[28] Marathon Oil (ING340018; steam condensate hydrostatic test waters) was formerly permitted to discharge in this HU.

F-2.11.3.4 Unregulated Livestock Operations

No CAFOs or CFOs are in this subwatershed. Within the TMDL subwatershed, SJRWI (2008a) observed livestock during windshield surveys at 5 locations in DeKalb County and 56 locations in Noble County; no livestock with direct access to streams was observed and manure storage was observed at one location in DeKalb County. Between 1 and 12 animals were observed at 50 locations; 15 to 30 animals, 10 locations; and 150 animals, one location. No additional information about hobby farms and small livestock operations are available. Thus, livestock may contribute nutrients loads that impair this HU.

F-2.11.3.5 Crop Production

As shown in Figure F-22, corn and soybean cropland is the dominant source of TSS loading in the TMDL subwatershed. Except in the town of La Otto, most of this subwatershed is agricultural land with occasional woodlots. An analysis of aerial imagery shows that streams throughout this subwatershed are channelized without forested riparian buffers. Most rural residences are adjacent to row crop fields.

F-2.12 King Lake-Little Cedar Creek (HUC 04100003 07 05)

With the exception of the town of Avilla and city of Garrett in the headwaters of unnamed tributaries to Little Cedar Creek, this HU is predominantly agricultural, with most rural residences adjacent to row crop fields. Several subdivision have developed near Avilla, Garrett, and in the lower segments of Little Cedar Creek below the confluence of Black Creek (e.g., around the Holiday Lakes). Numerous small ponds and woodlots are scattered across the landscape. King Lake is south of Avilla and is an in-channel lake along an unnamed tributary of Little Cedar Creek.

F-2.12.1 Monitoring Data

Samples were collected by IDEM (Section F-2.12.1.1) and SJRWI (SectionF-2.12.1.2). IDEM listed two segments of Little Cedar Creek (INA0375_05 and INA0375_06) and a segment of an unnamed tributary to Little Cedar Creek (INA0375_T1007) for IBC. IBC listings are addressed via TP and TSS TMDLs when one or both parameters exceeds its target. As TSS occasionally exceed the target, the IBC listing was addressed through the development of a TSS TMDL at the mouth of Little Cedar Creek (i.e., the outlet of the subwatershed).

F-2.12.1.1 IDEM

Three samples collected from Little Cedar Creek (LEJ090-0033) in 2005 were evaluated for TP (0.05 to 0.15 mg/L). TSS was detected in only one sample (40 mg/L); which exceeded the TSS target. DO was monitored at eight sites and ranged from 6.18 to 8.04 mg/L. Three samples collected from an unnamed tributary to Cedar Creek (LEJ090-0002) in 2000 were evaluated for TP (0.075 to 0.180 mg/L), TSS (6 to 35 mg/L), and DO (2.35 to 7.85 mg/L).

F-2.12.1.2 SJRWI

SJRWI sampled Little Cedar Creek (site 103 and 111). Samples collected in 2008 through 2013 at site 103 were evaluated for TP (Table F-2). TP results exceeded the target (15 of 175 results; 8.6 percent).

F-2.12.2 Load Duration Curve

A LDC was developed for Little Cedar Creek (Figure F-23) and TSS data collected by IDEM in 2005 are displayed as loads[29]. An exceedance of the LDC occurred in the low flow zone. To achieve the TMDLs (i.e., reduce loads to the LDCs), a reduction of 25 percent is necessary.

[29] TP and TSS concentrations from IDEM samples were multiplied by SWAT-simulated flows and converted to appropriate units.

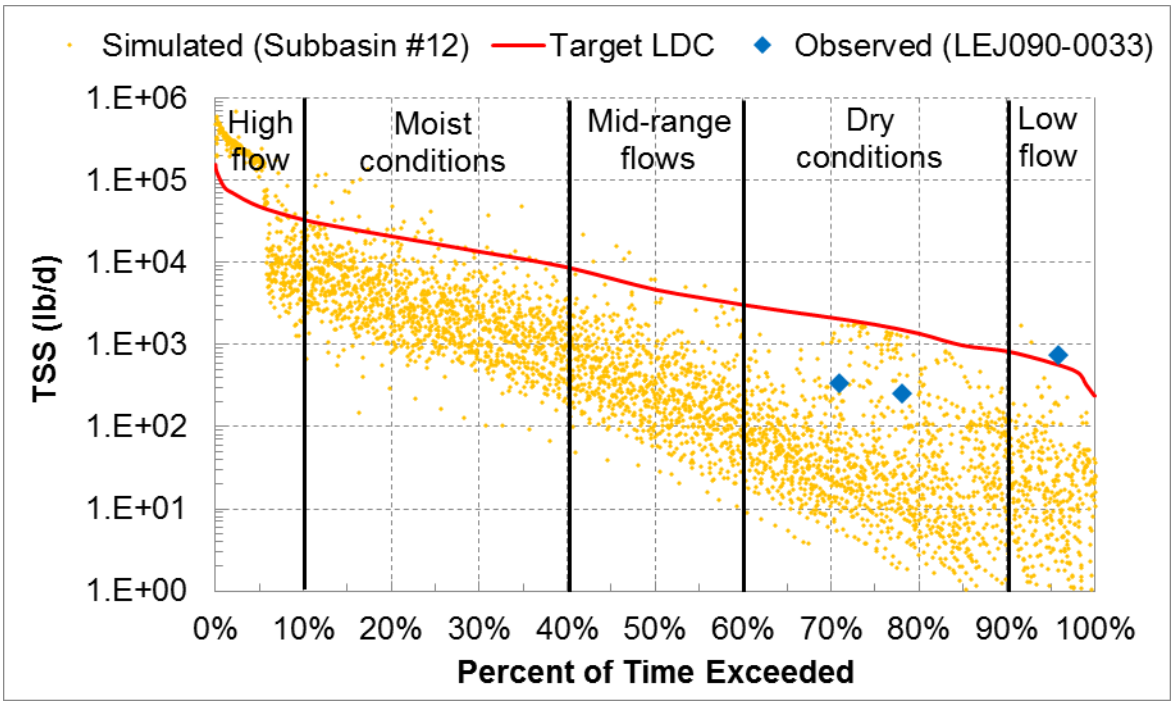
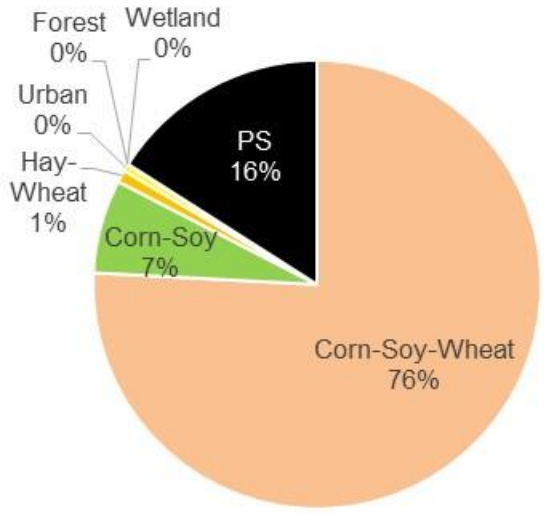


Figure F-23. TSS loads and LDC for Little Cedar Creek in *King Lake-Little Cedar Creek* (*07 05) at the HU outlet.

F-2.12.3 Sources of Impairment

SWAT-simulated source loads[30] indicate that corn and soybean crops are the dominant source of TSS load to Little Cedar Creek in this HU (Figure F-24).

[30] SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) within a single model subbasin. These loads also include model inputs from certain point sources (e.g., WWTPs). Such loads are inputs to the model reaches and do not account for in-stream processes. These loads are plotted as annual average loads across the 11-year SWAT model simulation period. As the TMDL subwatersheds are composed of multiple model subbasins, the results per subbasin are summed.



Notes
"PS" = permitted point sources.
Relative loads are rounded to the nearest percentage point.
SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) and the loads derived from model inputs for certain point sources. Such loads are inputs to the model reaches and do not account for in-stream processes. Results are summarized as the 11-year average of annual loads by source category.

Figure F-24. Summary of SWAT-simulated annual TSS loads that drain to Little Cedar Creek at the outlet of *King Lake-Little Cedar Creek* (*07 05).

The potential sources of nutrients in this HU are evaluated in the following sections.[31]

F-2.12.3.1 Public Facilities with Individual NPDES Permits

Three public facilities are covered by individual NPDES permits (see Figures C-3 and C-4 for maps and Table F-3 for DMR data).

- **Avilla WTP** (IN0052035; 34,000 gpd) is a WTP that discharges filter backwash to an unnamed tributary of Kings Lake. Effluent volumes were fairly consistent (0.030 to 0.051 cfs, average 0.037 cfs), while TSS concentrations (1 to 19 mg/L, average 6 mg/L) and loads (0.1 to 3.8 lbd/s, average 1.1 lbs/d) were very low. While the WTP is a source of TSS, its loads are very small and are an insignificant contributor to TSS loads in Little Cedar Creek.
- **Avilla WWTP** (IN0020664; 200,000 gpd) is a sanitary POTW that discharges to an unnamed tributary of Kings Lake. Effluent volumes varied considerably (0.053 to 0.819 cfs, average 0.514 cfs), while TSS concentrations (2 to 15 mg/L, average 7 mg/L) were very low. TSS loads varied with occasional larger loads (1.4 to 49.0 lb/d, average 20.7 lbs/d). An evaluation of SWAT-simulated in-stream loads indicates that effluent loads are orders of magnitude less than in-stream loads.
- **Indian Springs Recreational Campground** (IN0032107; 40,000 gpd) is a sanitary POTW that discharges seasonally to Little Cedar Creek. Effluent flows ranged from 0.001 to 0.032 cfs (average 0.008 cfs) during April through October. TSS concentrations (1 to 25 mg/L, average 8 mg/L) and loads (0.01 to 1.67 lb/d, average 0.36 lb/d) were very low. An evaluation of SWAT-simulated in-stream loads indicates that effluent loads are orders of magnitude less than in-stream loads.

[31] No industrial facilities with individual NPDES permits, communities with CSOs or SSOs, or regulated MS4s are in this subwatershed.

F-2.12.3.2 Facilities Covered by General NPDES Permits

Two industrial facilities in the town of Avilla hold general NPDES permit coverage for industrial stormwater (INRM01208 and INRM01494 in Table C-3). Ten construction site held coverage for stormwater.

F-2.12.3.3 On-Site Wastewater Treatment Systems

Outside of the town of Avilla, city of Garrett, and Indian Springs Recreational Campground, which are all served by POTWs, OWTS are the main methods of sanitary treatment. As this subwatershed is mostly composed of crop fields and woodlots, illicit cross-connections between OWTS and agricultural drain tiles are likely. Grandfathered or illicit off-site discharging OWTS, failing on-lot OWTS, and illicit OWTS connections to drain tiles likely contribute TP and TSS loads.

F-2.12.3.4 Unregulated Livestock Operations

No CAFOs or CFOs are in this subwatershed. Within the TMDL subwatershed, SJRWI (2008a) observed livestock during windshield surveys at 51 locations in DeKalb County and 119 locations in Noble County; no manure storage or livestock with direct access to streams were observed. No additional information about hobby farms and small livestock operations are available. Thus, livestock may contribute nutrients loads that impair this HU.

F-2.12.3.5 Crop Production

As shown in Figure F-24, cropland is the dominant source of TP loading in the TMDL subwatershed. Except in the town of Avilla and city of Garrett, most of this subwatershed is agricultural land with occasional woodlots and ponds. An analysis of aerial imagery shows that streams throughout this subwatershed are channelized without forested riparian buffers. Most rural residences are adjacent to row crop fields. The lower reaches of Little Cedar Creek (below Black Creek) are bounded by large, forested riparian buffers.

No septage land application is permitted in this subwatershed. Application of biosolids from the Garrett WWTP was permitted on five fields (164 acres; 1990-1995 and unknown years) in the eastern portion of the HU drained by an unnamed tributary to Little Cedar Creek; no information on any actual applications is available. Manure application likely occurs on farms; the sources of such manure are small livestock operations. No application date, volume, or rate data are available; thus, the significance of manure application cannot be determined.

F-2.13 Dosch Ditch-Cedar Creek (HUC 04100003 07 07)

This HU begins on Cedar Creek at the confluence of John Diehl Ditch and ends at the confluence of Cedar Creek with the SJR just below the Cedarville Reservoir. The Garret City Ditch and Schmadel Ditch discharge to Cedar Creek in the northern portion of this HU. Little Cedar and Willow creeks discharge to Cedar Creek in the southwest corner of this HU where Cedar Creek switches from flowing southwest to flowing southeast. The lower reaches of Cedar Creek flow through large, forested parcels.

Much of the city of Garrett and the outskirts of the city of Auburn are in the northern portion of this HU. The southeast, lower portion of the HU is composed of subdivisions and the suburban-rural transition along the city of Fort Wayne. Much of the land from Garrett and Auburn to Fort Wayne is row crops with adjacent rural residences.

F-2.13.1 Monitoring Data

Samples were collected by IDEM (Section F-2.13.1.1) and SJRWI (Section F-2.13.1.2). IDEM listed two segments of Cedar Creek (INA0377_03 and INA0377_04) and one segment of Dosch Ditch (INA0377_T1002) for IBC. IDEM also listed one segment of Dosch Ditch as impaired by nutrients. IBC

listings are addressed via TP and TSS TMDLs when one or both parameters exceeds its target. As TP and TSS both occasionally exceed targets, the IBC listings were addressed through the development of TP and TSS TMDLs at the mouth of Cedar Creek. The TP TMDL at the mouth of Cedar Creek will also address the nutrient impairment on Dosch Ditch.

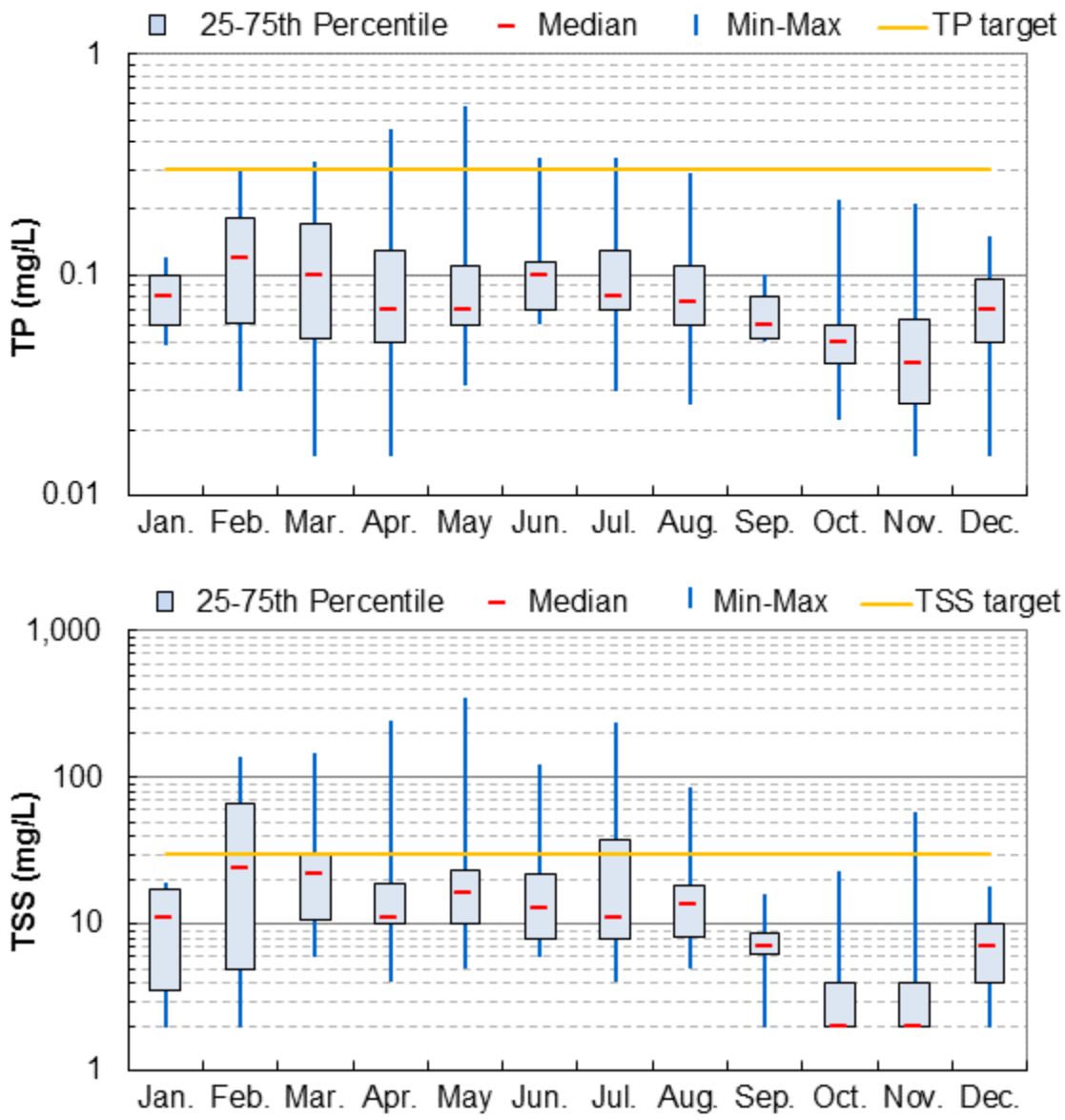
F-2.13.1.1 IDEM

IDEM sampled nine sites on Cedar Creek[32], one site on Dosch Ditch (LEJ090-0004), and five sites on Garrett City Ditch[33] (Table F-1). TP and TSS were evaluated for samples collected at five sites on Cedar Creek[34] and the single site on Dosch Ditch.

TP and TSS concentrations exceeded targets at three sites on Cedar Creek (Table F-1). No TP samples exceeded the target at site LEJ090-0008 (0.04 to 0.29 mg/L, n=31), while five samples exceeded the target at long-term site LEJ090-0026 (4 percent; 0.02 to 0.61 mg/L, n=146). Three TSS samples exceed the target at site LEJ090-0008 (10 percent; 2 to 86 mg/L, n=31) and 21 TSS samples exceeded the target at site LEJ090-0026 (14 percent, 2 to 346 mg/L, n=145). None of the three samples collected from Dosch Ditch exceeded applicable targets.

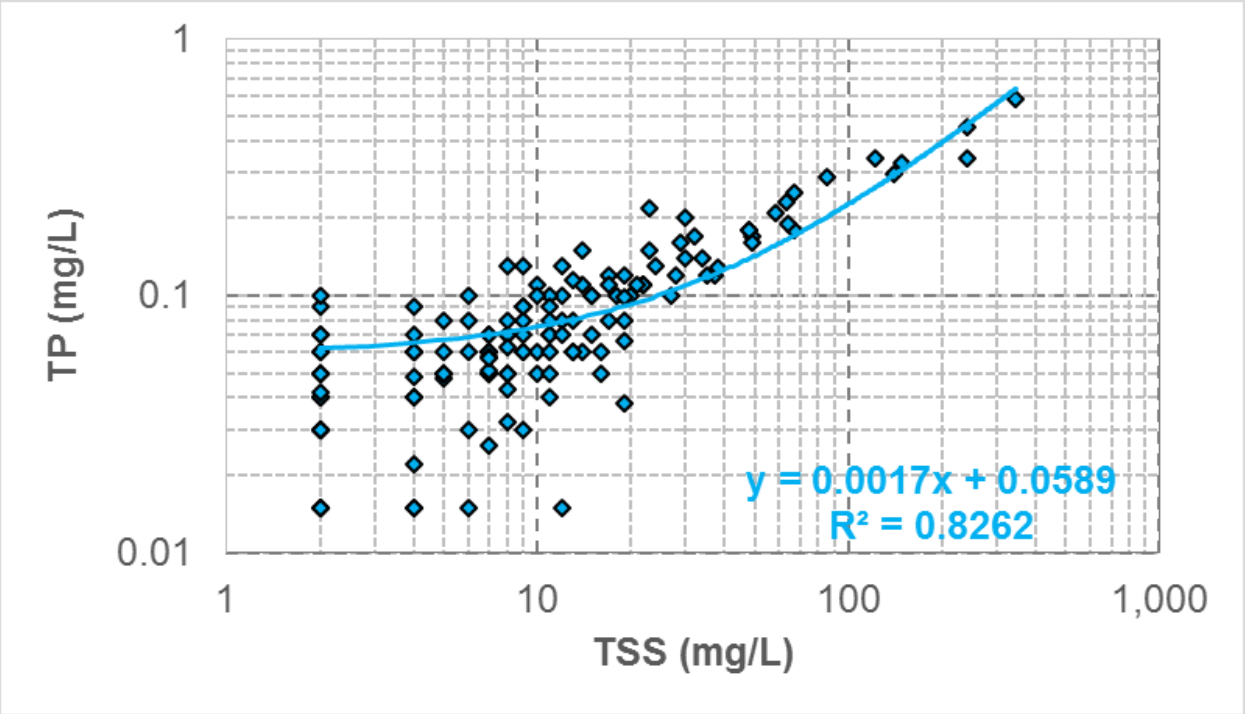
Long-term data collected at site LEJ090-0026 are summarized in Figure F-25. TP and TSS increase in the spring and decrease in the late summer and fall. TP was not detected in 6 samples (4 percent) and TSS was not detected in 21 samples (14 percent). A linear regression of TSS and TP (R^2=0.83) at site LEJ090-0026 may indicate a predictive relationship (Figure F-2). Such results likely indicate that TP is bound to sediment. When TP is sediment-bound, sources of sediment erosion (both upland and in-channel) typically increase the in-stream concentrations of TP and TSS.

[32] Sites LEJ090-0001, LEJ090-0003, LEJ090-0008, LEJ090-0009, LEJ090-0011, LEJ090-0021, LEJ090-0022, LEJ090-0026, and LEJ090-0031.
[33] Sites LEJ090-0012, LEJ090-0013, LEJ090-0014, LEJ090-0015, and LEJ090-0016.
[34] Sites LEJ090-0001, LEJ090-0003, LEJ090-0008, LEJ090-0026, and LEJ090-0031.



Note: 146 TP samples and 145 TSS samples collected 2001-2014.

Figure F-25. TP (top) and TSS (bottom) at site LEJ090-0026 on Cedar Creek.



Note: Non-detects were included in this analysis as one-half of the detection limit.

Figure F-26. Paired TP and TSS samples at site LEJ090-0026.

F-2.13.1.2 SJRWI

SJRWI sampled Cedar Creek (site 100, 107, and 109) and Garrett City Ditch (site 117). Samples collected in 2002 through 2014 at site 100 and in 2008 through 2013 at site 117 were evaluated for TP (Table F-2). TP results exceed at both sites 100 (27 of 354 results; 8 percent) and 117 (43 of 175 results; 25 percent).

F-2.13.2 Load Duration Curve

LDCs were developed for Cedar Creek (Figure F-27 and Figure F-28) and TP or TSS data collected by IDEM in 2004-2014 are displayed as loads[35]. Exceedances of the LDC only occurred in the high flow and moist conditions flow zones for TP and in the high flow, moist conditions, and mid-range flow zones for TSS. To achieve the TMDLs (i.e., reduce loads to the LDCs), reductions on a per sample basis, for the samples that exceed the TMDL target, range from 9 to 48 percent for TP and range from 6 to 91 for TSS.

[35] TP and TSS concentrations from IDEM samples were multiplied by SWAT-simulated flows and converted to appropriate units.

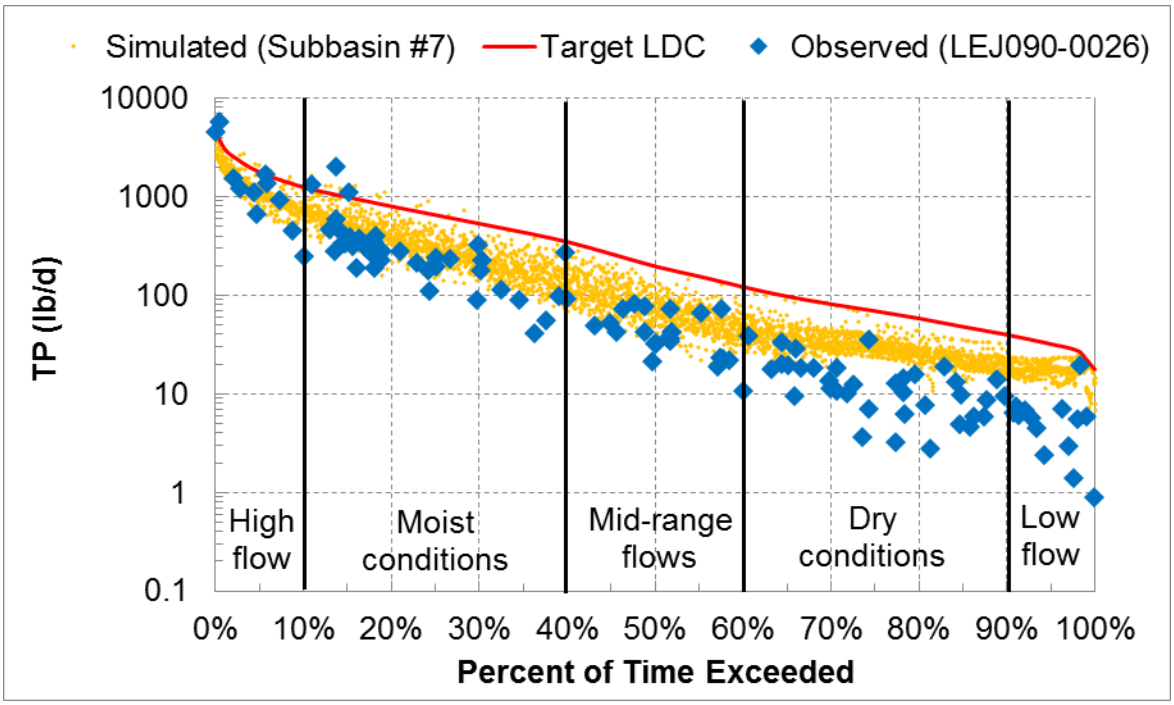


Figure F-27. TP loads and LDC for Cedar Creek in *Dosch Ditch-Cedar Creek* (*07 07) at the HU outlet.

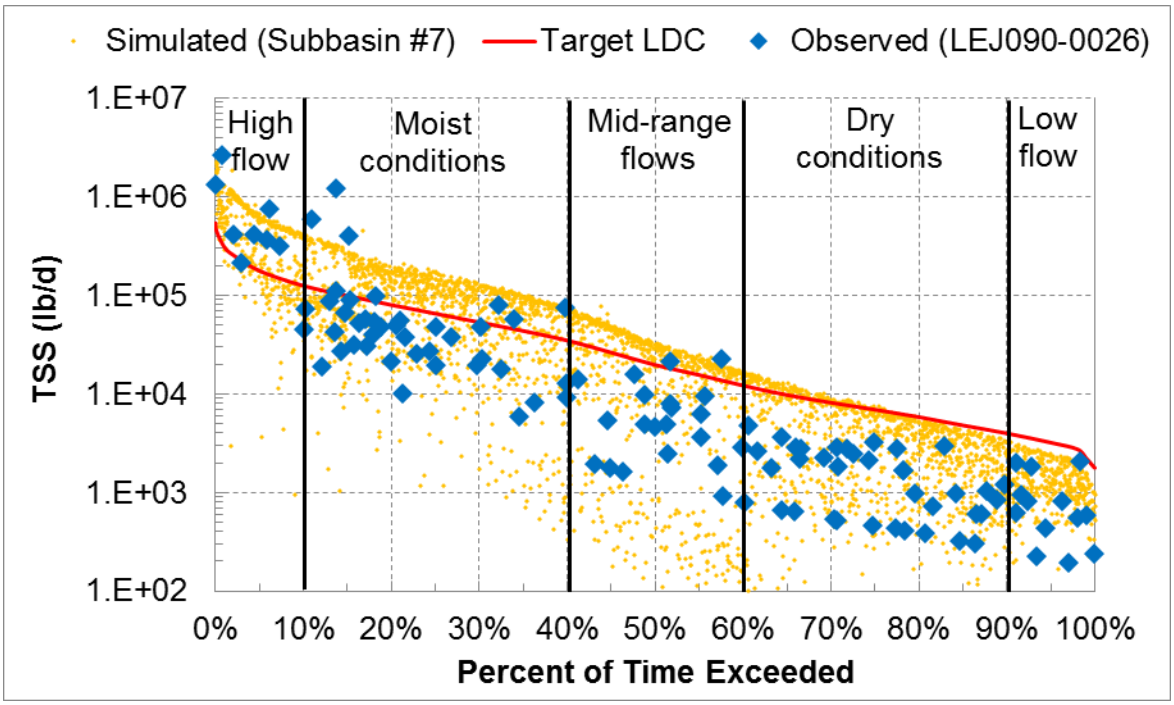
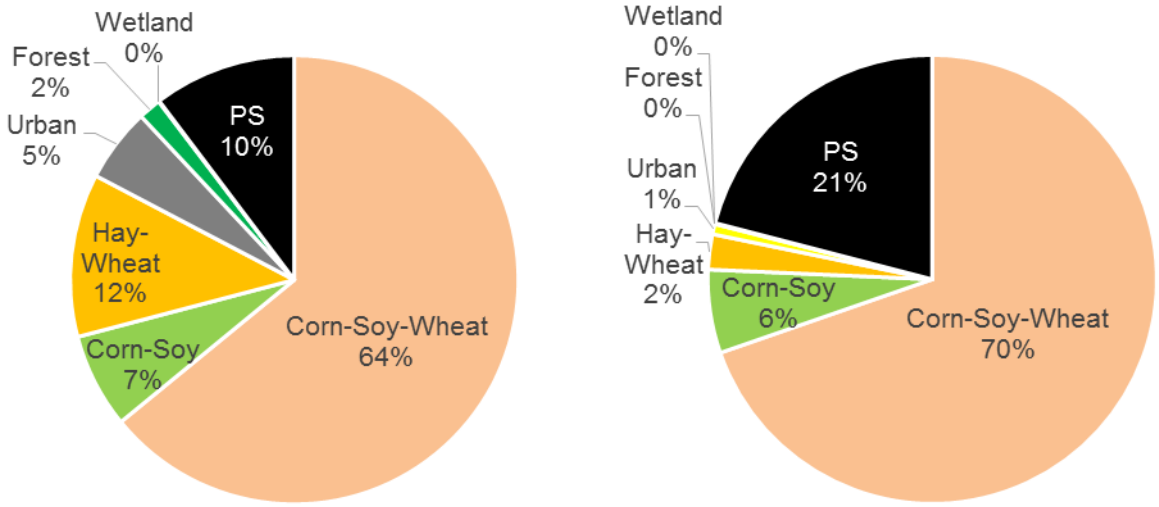


Figure F-28. TSS loads and LDC for Cedar Creek in *Dosch Ditch-Cedar Creek* (*07 07) at the HU outlet.

F-2.13.3 Sources of Impairment

SWAT-simulated source loads[36] indicate that corn and soybean crops are the dominant source of TP and TSS load to Cedar Creek (Figure F-29). Of the 11 HUs draining to the mouth of Cedar Creek, TP source load contributions per HU ranged from 6 to 13 percent of the total source load and for TSS, it ranged from 4 to 14 percent. Typically, the larger the HU, the larger the pollutant source loading.



Notes
"PS" = permitted point sources.
Relative loads are rounded to the nearest percentage point.
SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) and the loads derived from model inputs for certain point sources. Such loads are inputs to the model reaches and do not account for in-stream processes. Results are summarized as the 11-year average of annual loads by source category.

Figure F-29. Summary of SWAT-simulated annual TP (left) and TSS (right) loads that drain to Cedar Creek at the outlet of *Dosch Ditch-Cedar Creek* (*07 07).

The potential sources of nutrients in this HU are evaluated in the following sections.[37]

F-2.13.3.1 Public Facilities with Individual NPDES Permits[38]

One public facilities is covered by an individual NPDES permits (see Figures C-3 and C-4 for maps and Table F-3 for DMR data). The Garrett WWTP (IN0029969; 1.2 mgd) is a sanitary POTW that discharges to Garrett City Ditch. Effluent volumes were fairly consistent (0.7 to 1.9 cfs, average 1.1 cfs). TP concentrations (0.2 to 1.5 mg/L, average 0.5 mg/L) were high; TP loads varied with occasional larger loads (1 to 13 lbd/s, average 3 lbs/d). TSS concentrations (3 to 14 mg/L, average 6 mg/L) were low; TSS loads varied with occasional larger loads (13 to 115 lbd/s, average 34 lbs/d). Both TP and TSS effluent loads were orders of magnitude less than SWAT-simulated in-stream loads across most flow conditions.

[36] SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) within a single model subbasin. These loads also include model inputs from certain point sources (e.g., WWTPs). Such loads are inputs to the model reaches and do not account for in-stream processes. These loads are plotted as annual average loads across the 11-year SWAT model simulation period. As the TMDL subwatersheds are composed of multiple model subbasins, the results per subbasin are summed.

[37] No industrial or public facilities with individual or general NPDES permits, biosolids application fields, communities with CSOs or SSOs, or regulated MS4s are in this subwatershed.

[38] The following four permits were terminated: Auburn Foundry Landfill (IN0061590; stormwater), Auburn Rest Area I-69 North (IN0038504; sanitary), and Auburn Rest Area I-69 South (IN0038941; sanitary).

F-2.13.3.2 Facilities Covered by General NPDES Permits

Four industrial facilities in the town of Avilla hold general NPDES permit coverage for industrial stormwater (INRM00487, INRM00501, INRM00519, and INRM01740 in Table C-3). Seventeen construction site held coverage for stormwater. Allen County (INR040131, including the towns of Hunterstown and Leo-Cedarville), Auburn (INR040119), and Fort Wayne[39] (INR040029) are regulated MS4s.

F-2.13.3.3 On-Site Wastewater Treatment Systems

Outside of the cities of Auburn, Fort Wayne, and Garrett, which are all served by POTWs, OWTS are the main methods of sanitary treatment. As this subwatershed is mostly composed of crop fields and woodlots, illicit cross-connections between OWTS and agricultural drain tiles are likely. Grandfathered or illicit off-site discharging OWTS, failing on-lot OWTS, and illicit OWTS connections to drain tiles likely contribute TP and TSS loads.

F-2.13.3.4 Unregulated Livestock Operations

No CAFOs or CFOs are in this subwatershed. Within the TMDL subwatershed, SJRWI (2008a) observed livestock during windshield surveys at 149 locations in Noble County and 267 locations in DeKalb County. No additional information about hobby farms and small livestock operations are available. Thus, livestock may contribute nutrients loads that impair this HU.

F-2.13.3.5 Crop Production

As shown in Figure F-29, corn and soybean cropland is the dominant source of TP and TSS loading in the TMDL subwatershed. An analysis of aerial imagery shows that streams throughout this subwatershed are channelized and straightened, especially when flowing through crop fields. Many streams have very thin forested riparian buffers or are without buffers.

F-2.14 Becketts Run-St Joseph River (HUC 04100003 08 06)

This HU begins on the SJR at the confluence of Becketts Run and ends at the confluence of the SJR with the St. Mary's River where the Maumee River is formed. The HU is dominated by the city of Fort Wayne, with subdivisions along Becket's Run and downtown Fort Wayne and dense residential areas in the lower half of the HU.

F-2.14.1 Monitoring Data

Samples were collected by IDEM (Section F-2.14.1.1) and SJRWI (Section F-2.14.1.2). IDEM listed one segment of the SJR (INA0386_01) for IBC. IBC listings are addressed via TP and TSS TMDLs when one or both parameters exceeds its target. As TP and TSS both occasionally exceed targets, the IBC listings were addressed through the development of TP and TSS TMDLs at the mouth of the SJR. TMDLs were developed at the mouth, in lieu of the downstream terminus for segment INA0386_01, to support SJRW-scale implementation and to quantify loads from the SJRW to the Maumee River.

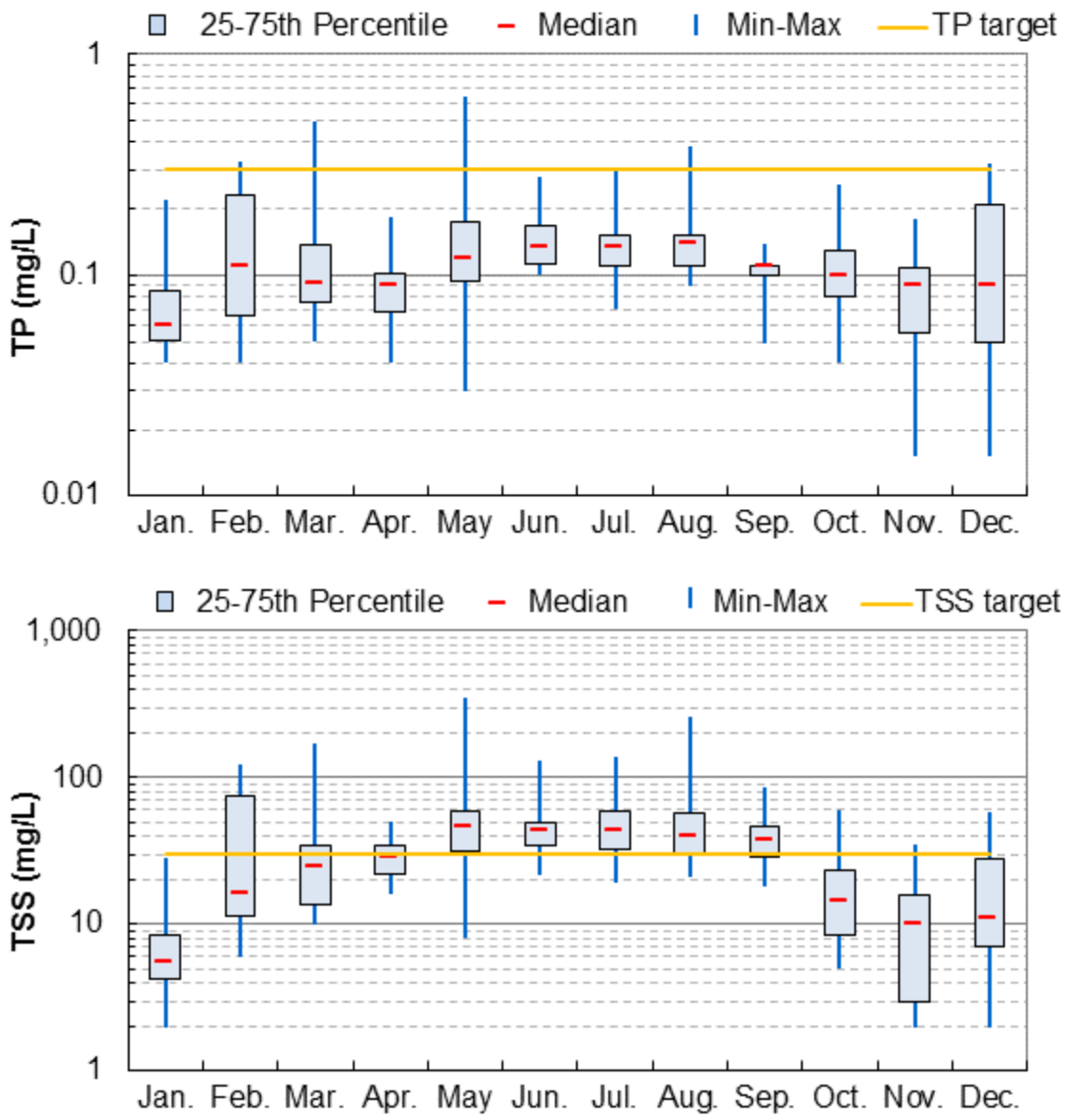
F-2.14.1.1 IDEM

IDEM sampled seven sites on the SJR[40] and one site on Becketts Run[41] (Table F-1) in Becketts Run-St. Joseph River (*08 06). TP and TSS were evaluated for samples collected at four sites on Cedar Creek[42] and the single site on Becketts Run.

[39] Regulated MS4 permit INR040029 covers the city of Fort Wayne, Indiana University-Purdue University - Fort Wayne, Ivy Tech State College - Northwest, the Indiana Institute of Technology, and the University of St. Francis. Refer to Section 4.2.5.4 of the main report for additional information on these MS4s.
[40] Sites LEJ08-0005, LEJ100-0003, LEJ100-0004, LEJ100-0013, LEJ100-0018, LEJ100-0016, LEJ100-0023, and LEJ100-0026.
[41] Site LEJ100-0001.
[42] Sites LEJ08-0005, LEJ100-0003, LEJ100-0023, and LEJ100-0026.

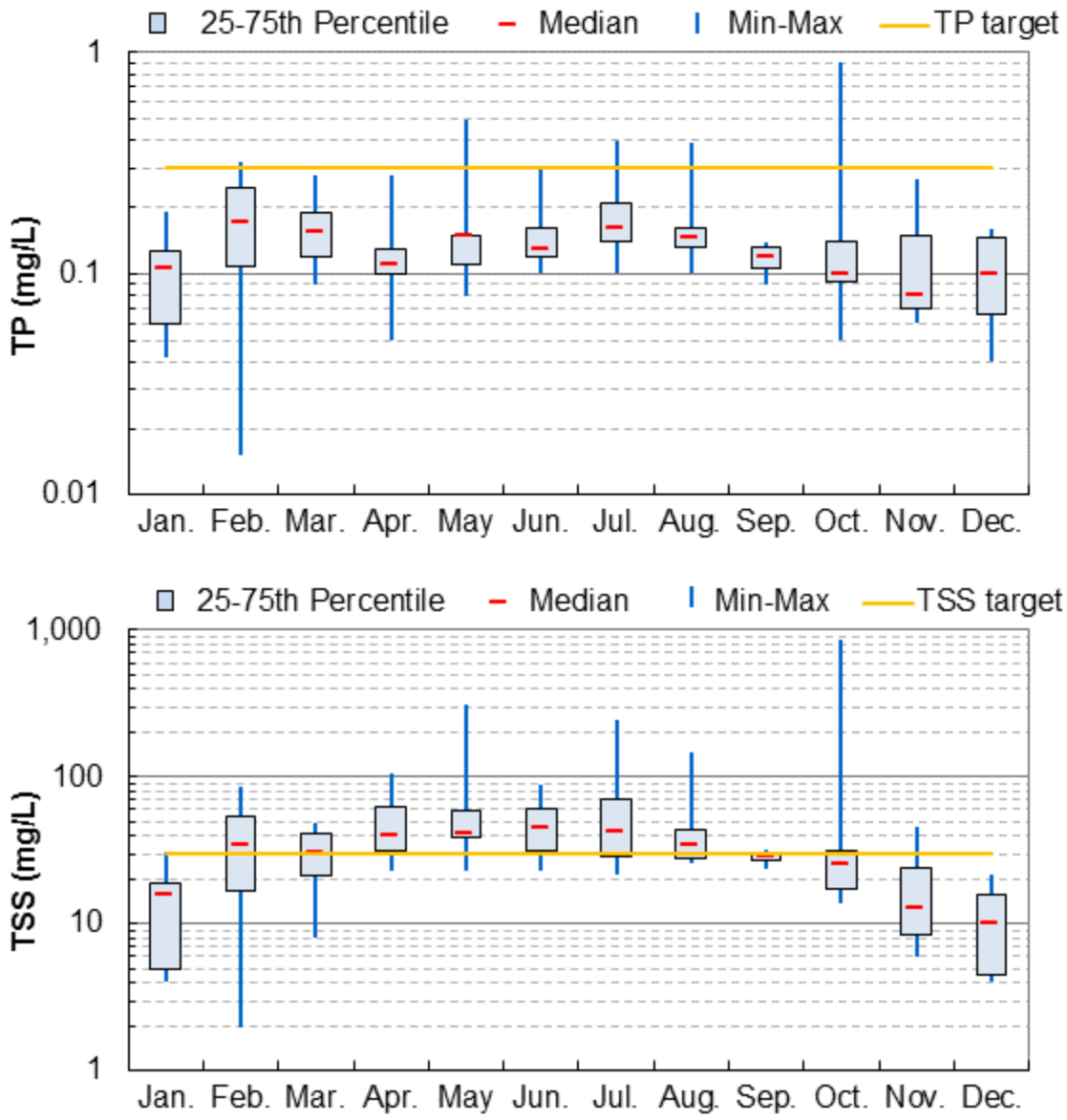
TP and TSS concentrations exceeded targets at three sites on the SJR and one site on Becketts Run (Table F-1). Samples collected at site LEJ08-0005 (n=44), LEJ100-0003 (n=247), and LEJ100-0026 (n=3) on the SJR and site LEJ100-0001 on Beckets Run (n=2) exceeded both the TP and TSS targets. Two samples collected at site LEJ100-0023 were evaluated for TP (and not TSS) and neither sample exceeded the target.

In addition to site LEJ100-0003 on the SJR in *08 02, long-term TP and TSS data were also collected by IDEM at sites LEJ060-0060 (*05 06) and LEJ100-0002 (*08 05). Data from these upstream sites, along segments of the SJR that are not impaired for their ALU, are presented for reference. Long-term data collected at site LEJ060-0006, LEJ100-0002, and LEJ100-0003 are summarized in Figure F-30, Figure F-31, and Figure F-32, respectively. Seasonal trends with TP are not as apparent on the SJR as elsewhere in the SJRW. Generally, most monthly interquartile ranges span the same range. TSS, however, shows an increasing trend during the spring and decreasing trend during the late summer and fall.



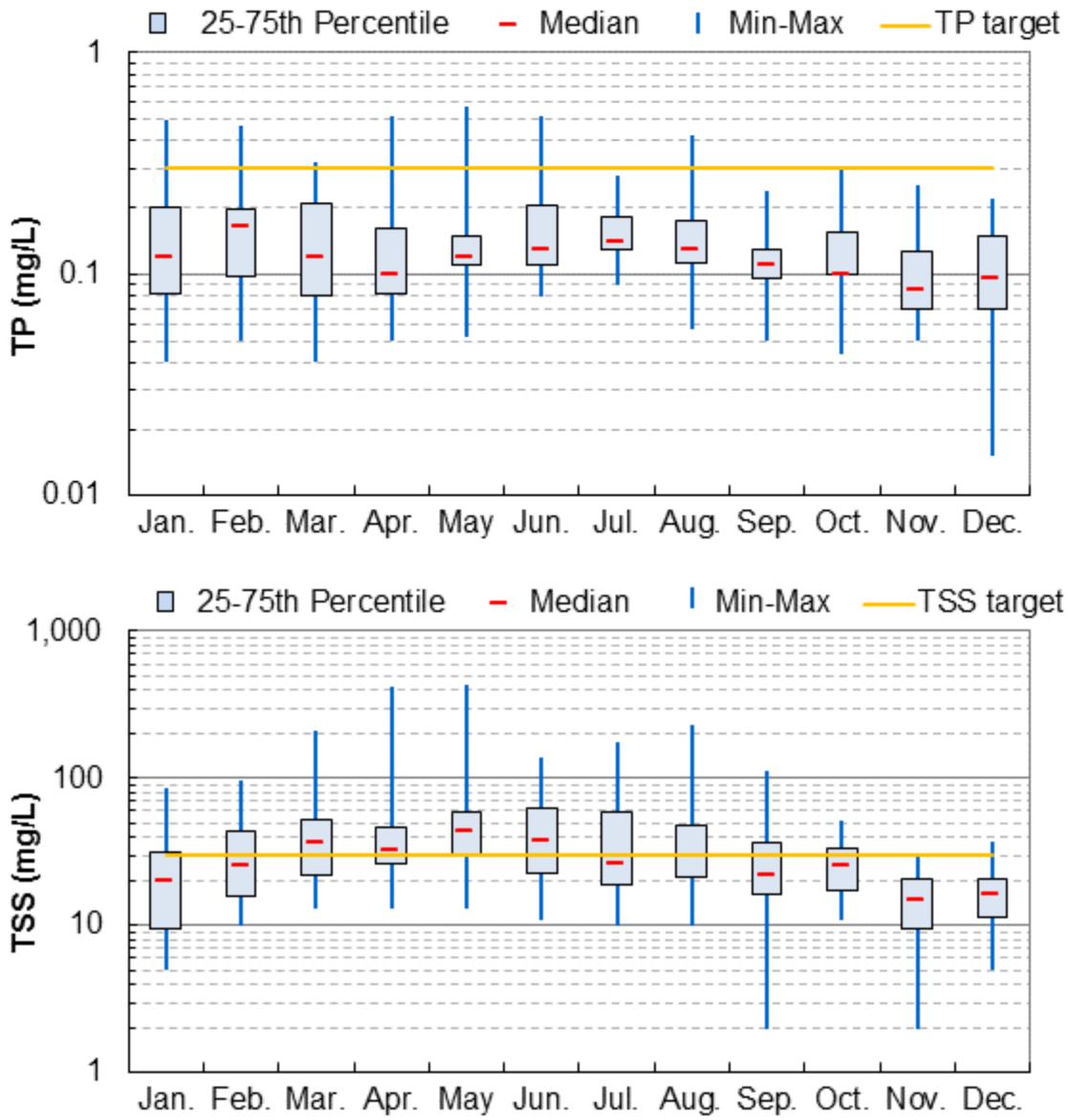
Note: 172 TP samples and 171 TSS samples collected 1999-2014.

Figure F-30. TP (top) and TSS (bottom) at site LEJ060-0006 on the St. Joseph River.



Note: 101 TP samples and 103 TSS samples collected 2001-2011.

Figure F-31. TP (top) and TSS (bottom) at site LEJ100-0002 on the St. Joseph River.



Note: 251 TP samples and 253 TSS samples collected 1991-2014.

Figure F-32. TP (top) and TSS (bottom) at site LEJ100-0003 on the St. Joseph River.

F-2.14.1.2 SJRWI

SJRWI sampled the SJR at two sites: St. Joe Dam (site 700) and Tennessee Bridge (site 601).Much of SJRWI's TP data were collected at upstream sites.

F-2.14.2 Load Duration Curve

LDCs were developed for the SJR (Figure F-33 and Figure F-34) and TP or TSS data collected by IDEM in 2004-2014 are displayed as loads[43]. Exceedances of the LDC only occurred in the high flow and moist conditions flow zones for TP and in all flow zones except the low flow zone for TSS. To achieve the

[43] TP and TSS concentrations from IDEM samples were multiplied by SWAT-simulated flows and converted to appropriate units.

TMDLs (i.e., reduce loads to the LDCs), reductions on a per sample basis, for the samples that exceed the TMDL target, range from 3 to 47 percent for TP and range from 3 to 93 for TSS.

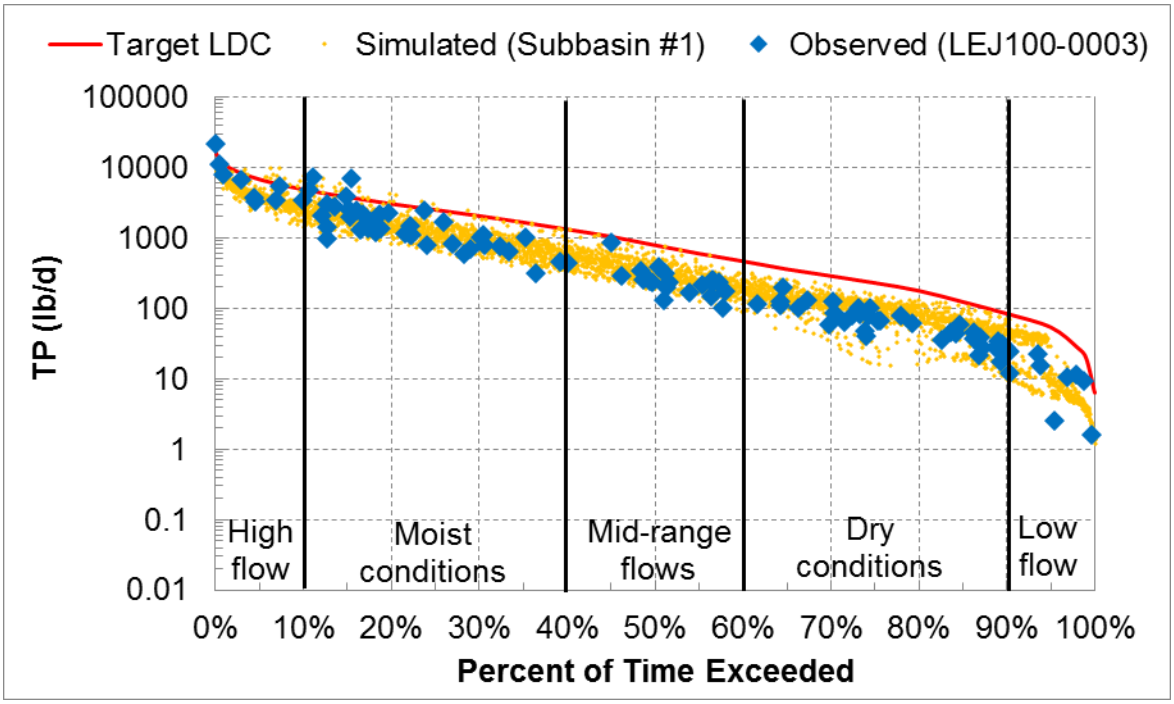


Figure F-33. TP loads and LDC for the SJR in *St. Joseph River* (*08 06) at the HU outlet.

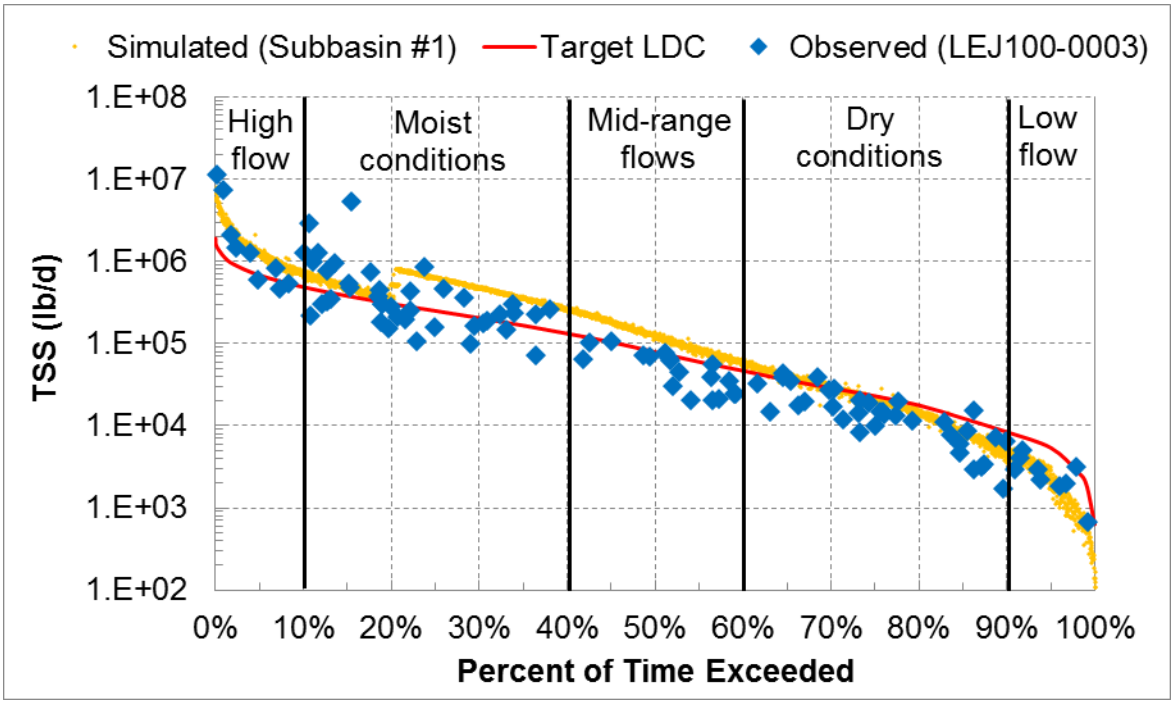
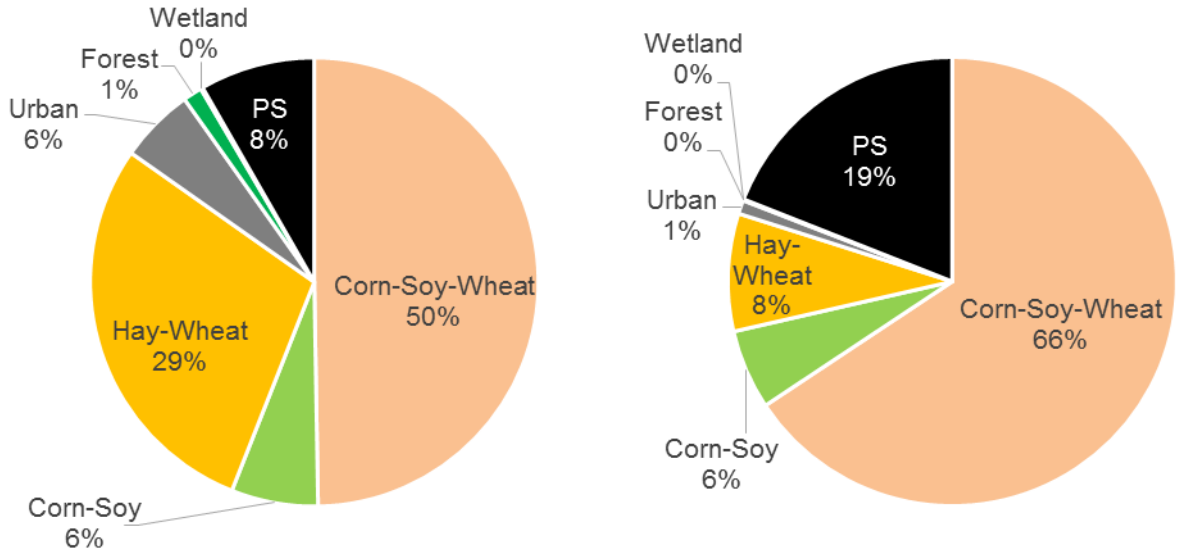


Figure F-34. TSS loads and LDC for the SJR in *St. Joseph River* (*08 06) at the HU outlet.

F-2.14.3 Sources of Impairment

SWAT-simulated source loads[44] indicate that corn and soybean crops are the dominant source of TP and TSS load to the SJR (Figure F-35). An analysis of Beckett's Run-St. Joseph River (*06 06) indicates that 51 percent of TP source load is derived from urban development; however, on the scale of the SJRW, agriculture upstream of the greater Fort Wayne area dominates all other sources.

Across the SJRW, 56 percent of the TP source load is from Indiana, 23 percent is from Ohio, and 21 percent is from Michigan; these results do not account for in-stream processes. Similarly, 63 percent of the TSS source load is from Indiana, 18 percent is from Michigan, and 19 percent is from Ohio TP source loads from the eight HUC10s vary from 9 to 17 percent of the total load across the SJRW and roughly coincide with land area per HUC10.



Notes
"PS" = permitted point sources.
Relative loads are rounded to the nearest percentage point.
SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) and the loads derived from model inputs for certain point sources. Such loads are inputs to the model reaches and do not account for in-stream processes. Results are summarized as the 11-year average of annual loads by source category.

Figure F-35. Summary of SWAT-simulated annual TP (left) and TSS (right) loads that drain to the SJR at the mouth.

The potential sources of nutrients and TSS are evaluated in the following sections.[45]

F-2.14.3.1 Industrial and Public Facilities with Individual NPDES Permits

Two facilities are covered by individual NPDES permits[46] (see Figures C-3 and C-4 for maps).

[44] SWAT-simulated source loads represent the loads derived runoff from various hydrologic response units (defined by the land cover, hydrologic soil group, and slope of a small area) within a single model subbasin. These loads also include model inputs from certain point sources (e.g., WWTPs). Such loads are inputs to the model reaches and do not account for in-stream processes. These loads are plotted as annual average loads across the 11-year SWAT model simulation period. As the TMDL subwatersheds are composed of multiple model subbasins, the results per subbasin are summed.

[45] No facilities with general NPDES permits, communities with CSOs or SSOs, or regulated MS4s are in this subwatershed.

- **DuPont Water Treatment Plant - North End** (IN0060127; 0.1 mgd) is a WTP that discharges to a wetland that is tributary to Keefer Creek. WTPs are not permitted to discharge TP or TSS. This facility has been terminated, however discussion is still relevant since it has active during the SWAT modeled flows.
- **Fort Wayne Municipal WWTP** (IN0032191; 60 mgd) is a major sanitary WWTP that discharges treated effluent to the Maumee River, which the SJRW is tributary to.

  Fort Wayne is a CSO and SSO community. In the SJRW, six CSO outfalls discharge to the SJR, three SSO outfalls discharge to Salgy Drain, and one SSO outfall discharges to Krunckenberg Ditch. In 2010 through 2014, the six CSO outfalls discharged between 12 and 171 times. CSO volumes ranged from <0.01 to 9.98 million gallons per month. The end point of the long-term control plan and federal consent decree is for one CSO event per year. While these outfalls are downstream of the ALU impaired segments on the SJR, they do contribute to TP and TSS load discharged to the Maumee River.

F-2.14.3.2 Facilities Covered by General NPDES Permits

In *Becketts Run-St. Joseph River* (*08 02), two industrial facilities, 63 construction sites and two MS4s are covered by general NPDES permits. Portions of the city of Fort Wayne (INR040029) are a regulated as an MS4; such areas exclude the sewersheds draining the CSS. The other regaled MS4 is Allen County (INR040131), which excludes Fort Wayne and Fort Wayne's co-permittees.

F-2.14.3.3 On-Site Wastewater Treatment Systems

Outside of the cities of Fort Wayne, OWTS are the main methods of sanitary treatment. As a portion of this subwatershed is composed of crop fields and woodlots, illicit cross-connections between OWTS and agricultural drain tiles are likely. Grandfathered or illicit off-site discharging OWTS, failing on-lot OWTS, and illicit OWTS connections to drain tiles likely contribute TP and TSS loads.

F-2.14.3.4 Unregulated Livestock Operations

No CAFOs or CFOs are in this subwatershed. SJRWI inventoried livestock across the SJRW through windshield surveys in 2009 and identified "1,218 locations where livestock were present" (Quandt 2015, p. 58). No additional information about hobby farms and small livestock operations are available. Thus, livestock may contribute nutrients loads that impair this HU.

F-2.14.3.5 Crop Production

As shown in Figure F-35, corn and soybean cropland is the dominant source of TP and TSS loading in the TMDL subwatershed. An analysis of aerial imagery shows that streams throughout this subwatershed are channelized and straightened, especially when flowing through crop fields. Many streams have very thin forested riparian buffers or are without buffers.

[46] The following facility no longer has a permit: Beatrice Cheese Company (IN0000261. The following two permits were terminated or otherwise no longer have permit coverage: Leo Elementary and High Schools (IN0025267; sanitary) and St. Joseph – Spencerville Regional Sewer District (IN0058411; sanitary).

F-3. Recreational Use Linkage Analysis

This section presents the recreation use (RU) linkage analyses for the 67 impaired segments in Indiana's portion of the SJRW (refer to Section 2 of the main report for a summary, map, and table of Indiana's RU impairments). The RU impairments s were evaluated on the scale of a hydrologic unit defined by a 10-digit hydrologic unit code (HUC). All of the impairments were addressed through the development of *Escherichia coli* (*E. coli)* TMDLs at WAU outlets or state borders.

F-3.1 Project Area Data

Ambient water quality data and discharge monitoring report (DMR) data are summarized in this section.

F-3.1.1 Summary of Water Quality Data

This section presents summary tables for *E. coli* data. Table F-5 and Table F-6 summarize *E. coli* concentrations in water quality samples collected by Ohio EPA and IDEM, respectively.

Table F-5. *E. coli* data summary for the SJRW in Ohio

Stream name	RM	Site ID	DA	RU	RU status	No. of samples	Min.	Max.	GM
Fish Creek (HUC 04100003 04)									
Headwaters Fish Creek (HUC 04100003 04 02)									
Fish Creek	30.54	P08K12	8.8	B	Non	5	250	**1,400**	**581**
Cornell Ditch-Fish Creek (HUC 04100003 04 06)									
Fish Creek	5.40	P08K10	106.0	B	Non	5	400	**780**	**575**
	0.38	P08S20	109.0	B	Non	5	530	**920**	**667**
Sol Shank Ditch-St. Joseph River (HUC 04100003 05)									
Bluff Run-St. Joseph River (HUC 04100003 05 01)									
SJR	56.77	P08S16	435.0	A	Non	5	230	**380**	**286**
Big Run-St. Joseph River (HUC 04100003 05 02)									
Big Run	0.30	P08K08	30.0	B	Non	5	230	**700**	**410**
Russell Run-St. Joseph River (HUC 04100003 05 03)									
SJR	49.75	510180	554.0	A	Non	5	280	**1,200**	**426**
Willow Run-St. Joseph River (HUC 04100003 05 06)									
SJR	42.34	510220	609.0	A	Non	10 [a]	20	**720**	**173**

Source: Ohio EPA 2014

Notes

Samples were collected in the year 2013, except as noted.

Bolded minima and maxima exceed the single sample maximum criteria and **bolded** geometric means exceed the seasonal geometric mean criteria.

a. In addition to the 5 samples collected in 2013, 3 samples each were collected in 2006 and 2007, and 2 samples were collected in 2008.

Table F-6. *E. coli* data summary for the SJRW in Indiana

Waterbody	IDEM site ID	RU segment status	No. of samples	Min.	Max.	GM
West Branch St. Joseph River (HUC 04100003 02)						
Headwaters Fish Creek (HUC 04100003 02 03)						
Clear Lake	LEJ020-0001	--	8	1	6	1
Fish Creek (HUC 04100003 04)						
West Branch Fish Creek (HUC 04100003 04 01)						
West Branch Fish Creek	LEJ050-0020	Not	2	1,553	2,105	1,808
	LEJ050-0064	Not	6	261	1,046	445
Headwaters Fish Creek (HUC 04100003 04 02)						
Fish Creek	LEJ050-0023	Not	2	1,553	9,208	3,782
Hamilton Lake (HUC 04100003 04 03)						
Hamilton Lake	LEJ050-0009	Insufficient data	6	11	37	20
Hiram Sweet Ditch (HUC 04100003 04 04)						
Fish Creek	LEJ050-0050	Insufficient data	3	291	1,210	495
	LEJ050-0052	Not	2	345	517	422
	LEJ050-0054	Not	2	365	727	515
Town of Alvarado-Fish Creek (HUC 04100003 04 05)						
Fish Creek	LEJ050-0010	Not	7	816	12,100	2,038
Fish Creek	LEJ050-0027	Not	2	2,419	3,448	2,888
Fish Creek	LEJ050-0029	Not	2	548	2,420	1,151
Fish Creek	LEJ050-0032	Not	2	687	1,046	848
Fish Creek	LEJ050-0066	Not	5	249	1,733	652
UT of Fish Creek	LEJ050-0026	Insufficient data	2	461	17,329	2,827
Cornell Ditch-Fish Creek (HUC 04100003 04 06)						
Fish Creek	LEJ050-0040	Not	3	770	866	801
	LEJ050-0008	Not	7	192	12,996	1,075
	LEJ050-0035	Not	2	488	548	517
	LEJ050-0007	Not	8	300	4,611	869
	LEJ050-0068	Not	5	308	1,733	548
UT of Fish Creek	LEJ050-0048	Insufficient data	2	461	2,419	1,056
Sol Shank Ditch-St. Joseph River (HUC 04100003 05)						
Big Run (HUC 04100003 05 02)						
Big Run	LEJ060-0015	Not	5	78	1,210	290
Hoodelmier Ditch-St. Joseph River (HUC 04100003 05 06)						
SJR	LEJ060-0006	not available	2	230	260	245
Matson Ditch-Cedar Creek (HUC 04100003 06)						
Cedar Lake-Cedar Creek (HUC 04100003 06 01)						
Cedar Creek	LEJ080-0005	Not	5	10	23,000	519
Leins Ditch	LEJ080-0016	Not	5	727	1,120	937
UT of Leins Ditch	LEJ080-0014	Not	5	99	276	155
Dibbling Ditch-Cedar Creek (HUC 04100003 06 02)						
Cedar Creek	LEJ080-0006	Not	6	110	2,000	247
Swartz Ditch	LEJ080-0008	Not	5	390	1,200	552
Matson Ditch (HUC 04100003 06 03)						
UT Mason Ditch	LEJ080-0013	Insufficient data	5	411	1,300	744
Smith Ditch-Cedar Creek (HUC 04100003 06 04)						
Cedar Creek	LEJ080-0007	Not	5	140	25,000	768
	LEJ080-0004	Not	6	649	7,701	1,499

	LEJ080-0009	Not	5	90	**1,500**	**270**
West Smith Ditch	LEJ080-0017	Not	6	20	**1,120**	**250**
Cedar Creek (HUC 04100003 07)						
Peckhart Ditch-John Diehl Ditch (HUC 04100003 07 02)						
John Diehl Ditch	LEJ090-0018	Not	5	220	**11,000**	**609**
Peckhart Ditch	LEJ090-0040	Insufficient data	5	29	105	64
	LEJ090-0034	Not	6	**1,210**	**19,863**	**7,196**
Black Creek (HUC 04100003 07 04)						
Black Creek	LEJ090-0041	Not	5	435	**1,046**	**701**
King Lake-Little Cedar Creek (HUC 04100003 07 05)						
Little Cedar Creek	LEJ090-0010	Not	5	272	**1,210**	**639**
	LEJ090-0033	Not	6	104	**2,419**	**476**
	LEJ090-0017	Not	4	220	**690**	**378**
Willow Creek (HUC 04100003 07 06)						
Willow Creek	LEJ090-0020	Insufficient data	5	260	**17,000**	**799**
Dosch Ditch-Cedar Creek (HUC 04100003 07 07)						
Cedar Creek	LEJ090-0021	Insufficient data	6	100	410	**236**
Cedar Creek	LEJ090-0031	Not	5	517	**1,986**	**692**
Cedar Creek	LEJ090-0008	Not	9	5	**6,867**	**243**
Cedar Creek	LEJ090-0011	Not	5	186	**3,130**	**873**
Garrett City Ditch	LEJ090-0015	Not	5	300	**8,200**	**864**
St. Joseph River (HUC 04100003 08)						
Metcalf Ditch-St. Joseph River (HUC 04100003 08 02)						
SJR	LEJ070-0008	Non	5	147	**1,733**	**610**
Swartz Cannahan Ditch-St. Joseph River (HUC 04100003 08 03)						
SJR	LEJ070-0027	Not	6	37	**649**	**148**
	LEJ070-0026	Not	5	35	**1,733**	**129**
Cedarville Reservoir-St. Joseph River (HUC 04100003 08 04)						
SJR	LEJ070-0006	Not	6	140	**3,448**	**424**
Ely Run-St. Joseph River (HUC 04100003 08 05)						
Tiernan Ditch	LEJ100-0005	Insufficient data	2	150	170	**160**
Becketts Run-St. Joseph River (HUC 04100003 08 06)						
SJR	LEJ100-0026	Insufficient data	5	45	261	87
	LEJ100-0004	Insufficient data	5	238	**14,136**	**1,336**
	LEJ100-0003	Insufficient data	82	5	**28,000**	**199**

Source: IDEM 2014, 2015
Notes Samples were collected in the year 2013, except as noted. **Bolded** minima and maxima exceeded the single sample maximum criteria and **bolded** geometric means exceeded the monthly geometric mean criteri

a.

F-3.1.2 Summary of Discharge Monitoring Report Data

DMR data for permitted facilities were provided by Ohio EPA and IDEM. Data for Ohio are limited to a single 12-digit HU (Table F-7Table F-7 DMR data for facilities that are not in 12-digit HUs that drain directly to Indiana are excluded. Indiana DMR data presented in Table F-8.

Table F-7. Summary of DMR data for facilities permitted to discharge bacteria in Ohio

OEPA ID	Outfall	Flow (cubic feet per second)				Fecal coliform concentration (counts per 100 milliliters)				Fecal coliform load (counts per day)			
		No. [a]	Min.	Max.	Avg.	No. [a]	Min.	Max.	Avg.	No. [a]	Min.	Max.	Avg.
Sol Shank Ditch-St. Joseph River (HUC 04100003 05)													
Bluff Run-St. Joseph River (HUC 04100003 05 01)													
2PB00047	001	483	0.033	6.34	2.644	22	1	1,600	247	22	4.3E+07	5.6E+10	1.2E+10
	801	--	--	--	--	3	182	3,300	1,261	--	--	--	--
	901	--	--	--	--	3	91	1,800	742	--	--	--	--

Source: Ohio EPA 2015

Notes

The following are excluded from this table: (1) facilities not permitted to discharge bacteria, and (2) facilities without bacteria DMR data.

Treated effluent is discharged through outfall 001 while upstream and downstream monitoring are reported as outfalls 801 and 901, respectively.

a. Number of DMR records for the specified parameter.

Table F-8. Summary of DMR data for facilities permitted to discharge bacteria in Indiana

NPDES ID	Outfall	Flow (cubic feet per second)				*E. coli* concentration [a] (counts per 100 milliliters)				*E. coli* load [b] (counts per day)			
		No. [c]	Min.	Max.	Avg.	No. [c]	Min.	Max.	Avg.	No. [c]	Min.	Max.	Avg.
Fish Creek (HUC 04100003 04)													
Hiram Sweet Ditch (HUC 04100003 04 04)													
IN0050822	001	132	0.202	0.398	0.280	77	2	34	7	77	1.2E+07	3.0E+08	5.0E+07
Sol Shank Ditch-St. Joseph River (HUC 04100003 05)													
Big Run-St. Joseph River (HUC 04100003 05 02)													
IN0022462	002	111	1.017	2.825	1.707	64	2	23	7	64	5.1E+07	1.5E+09	2.6E+08
Matson Ditch-Cedar Creek (HUC 04100003 06)													
Dibbling Ditch-Cedar Creek (HUC 04100003 06 02)													
IN0020711	001	132	0.174	1.067	0.460	76	1	868	20	76	4.4E+06	1.3E+10	2.9E+08
Smith Ditch-Cedar Creek (HUC 0100003 06 04)													
IN0020672	001	90	1.477	4.989	2.665	52	2.	233.	30	52	1.5E+08	2.1E+10	2.6E+09
Cedar Creek (HUC 04100003 07)													
Headwaters John Diehl Ditch (HUC 04100003 07 01)													
IN0047473	001	118	0.002	0.600	0.037	34	1	36,260	1,272	34	1.6E+06	9.8E+09	4.9E+08
Sycamore Creek-Little Cedar Creek (HUC 04100003 07 03)													
IN0020664	001	132	0.053	0.820	0.529	77	1	29	7	77	5.1E+06	3.5E+08	8.8E+07
Black Creek (HUC 04100003 07 04)													
IN0058611	001	99	0.002	0.788	0.122	6	6	1,720	318	6	1.2E+07	1.8E+10	3.4E+09
King Lake-Little Cedar Creek (HUC 04100003 07 05)													
IN0032107	001	70	0.001	0.046	0.008	44	1	2,000	162	44	1.2E+04	4.8E+08	3.3E+07
Dosch Ditch-Cedar Creek (HUC 04100003 07 07)													
IN0029969	001	89	0.722	1.938	1.137	46	1	60	15	46	1.9E+07	2.0E+09	3.8E+08
St. Joseph River (HUC 04100003 08)													
Swartz Cannahan Ditch-St. Joseph River (HUC 04100003 08 03)													
IN0059749	001	123	0.001	0.020	0.008	36	1	195	34	36	2.5E+05	4.4E+07	6.2E+06

Source: IDEM 2015

Notes

The following are excluded from this table: (1) facilities not permitted to discharge bacteria, and (2) facilities without bacteria DMR data.

Treated effluent is discharged through outfall 001 while upstream and downstream monitoring are reported as outfalls 801 and 901, respectively.

a. Monthly geometric mean of *E. coli* concentrations.

b. *E. coli* load calculated using monthly geometric mean of *E. coli* concentrations and monthly average flow.

c. Number DMR records for the specified parameter.

F-3.2 Fish Creek (HUC 04100003 04)

F-3.2.1 Monitoring Data

Ohio EPA collected 5 samples at three sites (Table F-5) in the Fish Creek subwatershed, while IDEM collected between 2 and 7 samples at 18 sites in the subwatershed (Table F-6). *E. coli* in Ohio ranged from 250 to 1,400 counts/100 mL, with geometric means from 575 to 667 counts/100 mL. All three Ohio assessment sites were in nonattainment. Excluding samples collected from Hamilton Lake, *E. coli* in Indiana ranged from 192 to 17,329 counts/100 mL, with geometric means from 445 to 2,888 counts/100 mL. RU attainment was assessed at 14 locations and IDEM found all 14 sites to be in nonattainment.

F-3.2.2 Load Duration Curves

LDCs were developed for the five HUC12s with segments impaired for their RUs: Figure F-36, Figure F-37, Figure F-38, Figure F-39, and Figure F-40. *E. coli* data collected by IDEM in 2005 and 2010 are displayed as loads[47] in some LDC figures. Data collected in 2000 and 2001 are not displayed because loads could not be calculated due to a lack of flow data[48].

All loads exceeded the LDCs. To achieve the TMDL (i.e., reduce loads to the LDC), reductions on a per sample basis range from 54 to 93 percent.

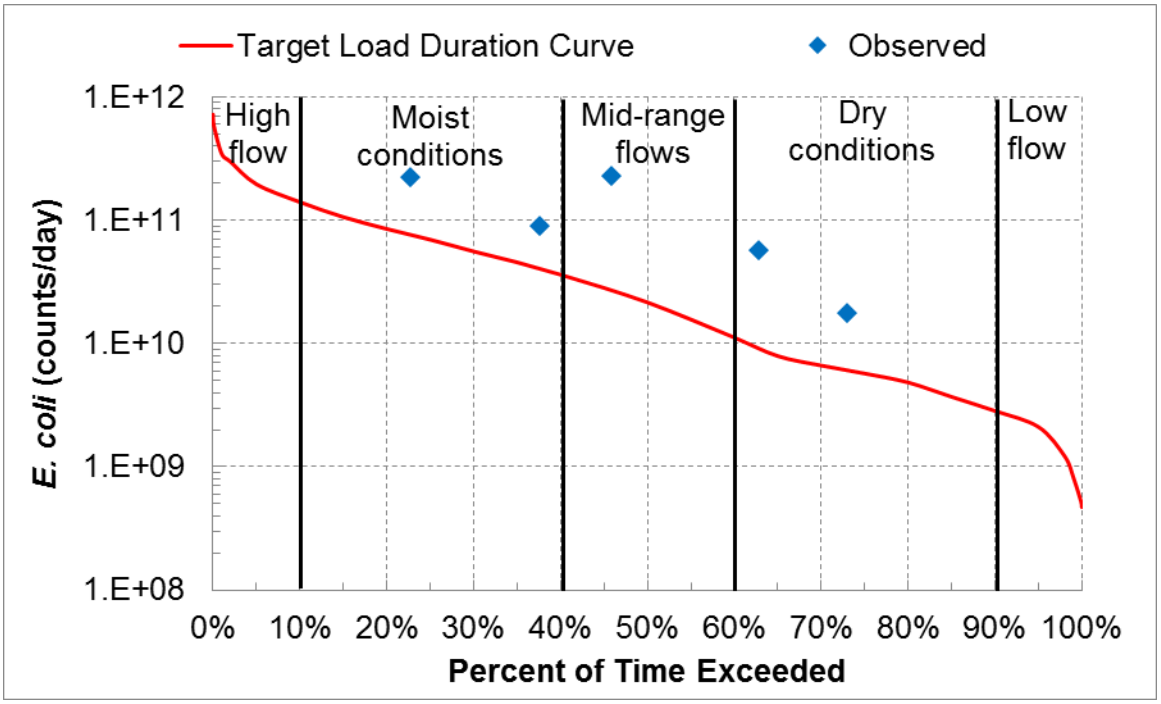


Figure F-36. *E. coli* loads and LDC for West Branch Fish Creek in *West Branch Fish Creek* (*04 01) at HU outlet.

[47] *E. coli* concentrations from IDEM samples were multiplied by SWAT-simulated flows and converted to appropriate units.
[48] The SWAT model was developed to simulate calendar years 2004 through 2014.

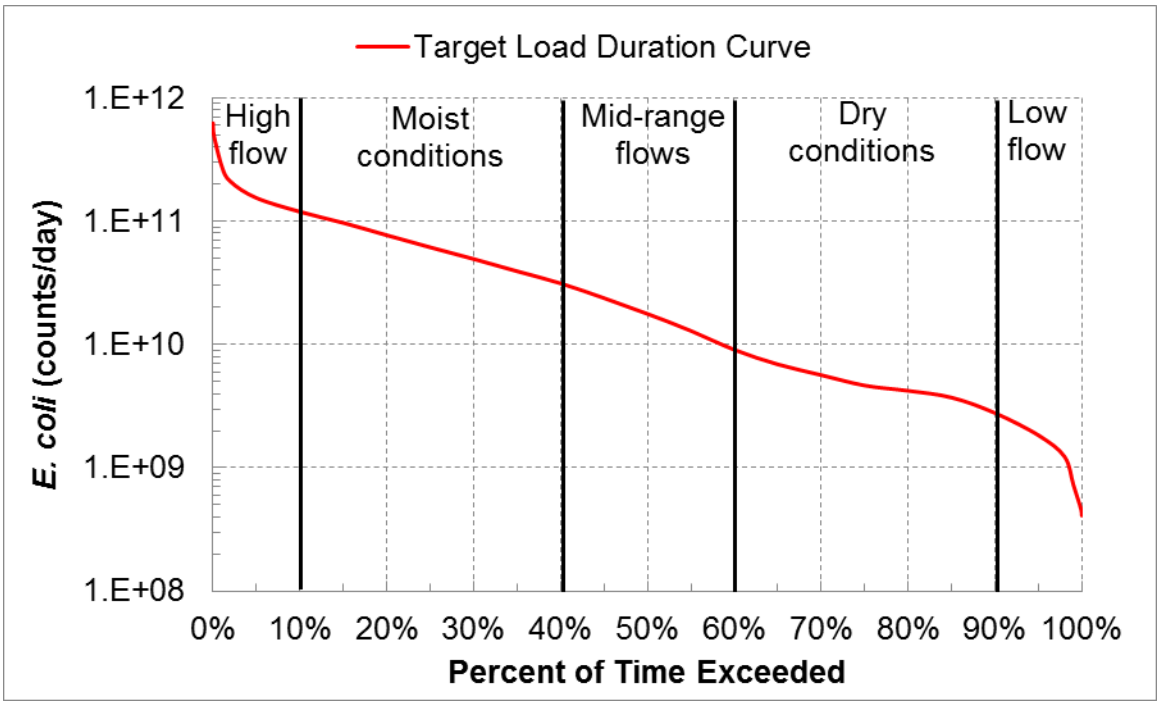


Figure F-37. *E. coli* LDC for Fish Creek in *Headwaters Fish Creek* (*04 02) at HU outlet.

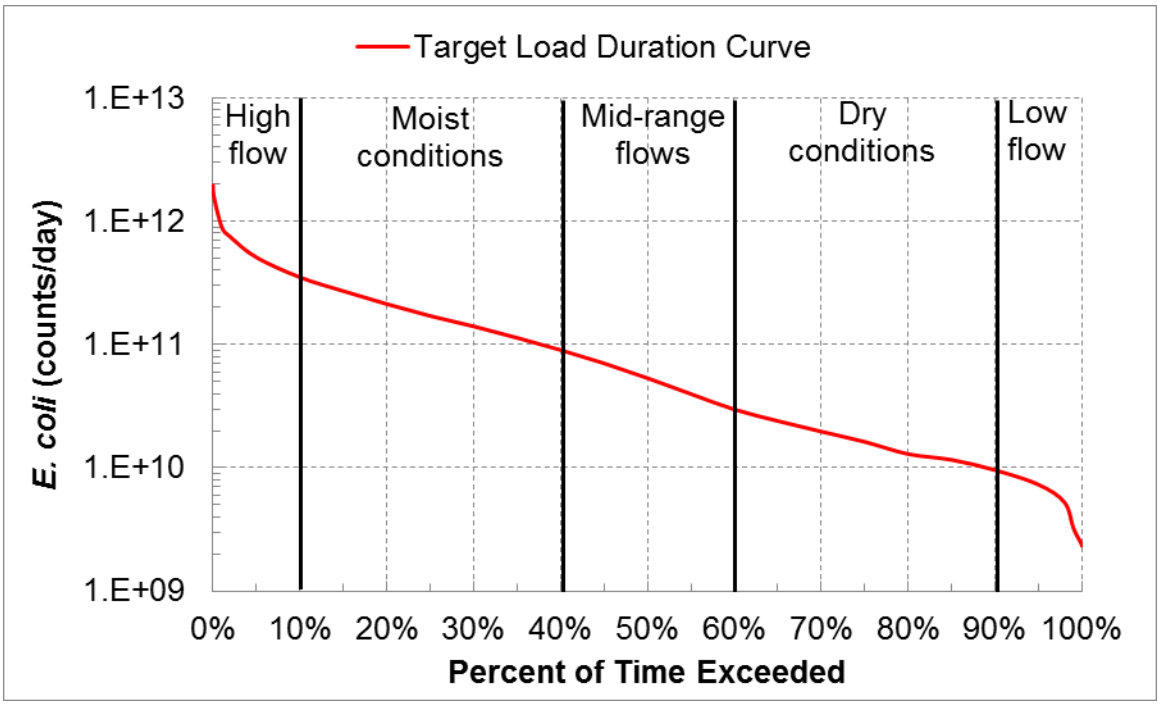


Figure F-38. *E. coli* LDC for Hiram Sweet Ditch in *Hiram Sweet Ditch* (*04 04) at HU outlet.

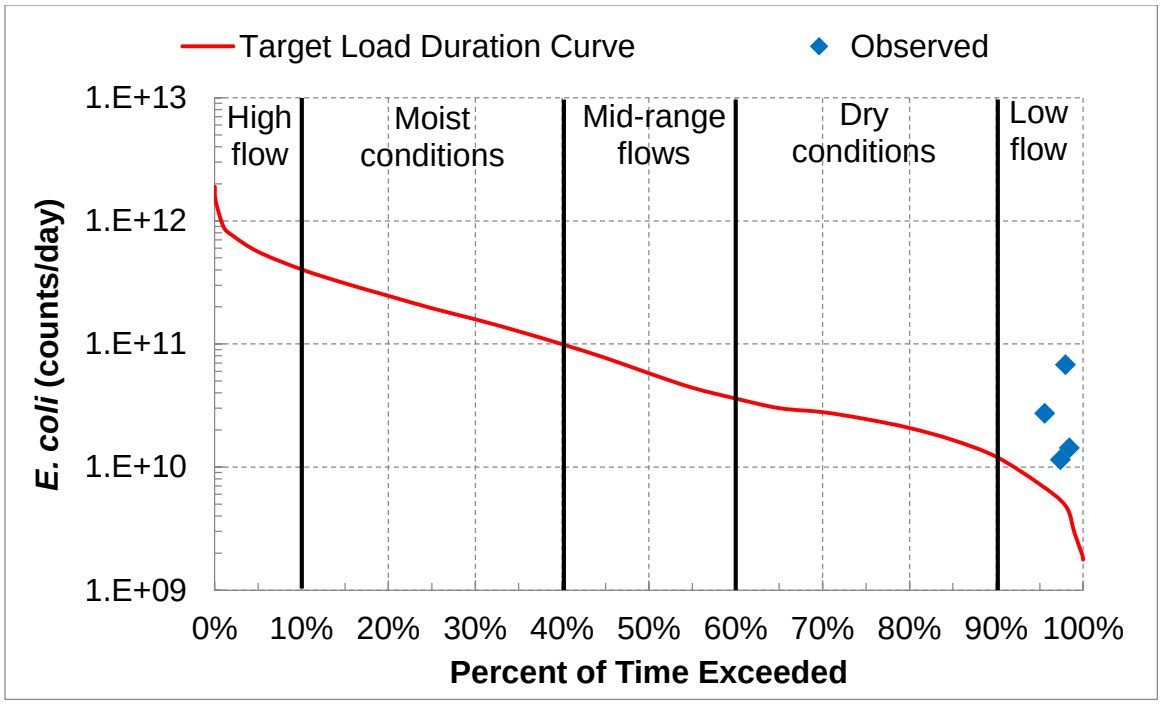


Figure F-39. *E. coli* loads and LDC for Fish Creek in *Town of Alvarado-Fish Creek* (*04 05) at HU outlet.

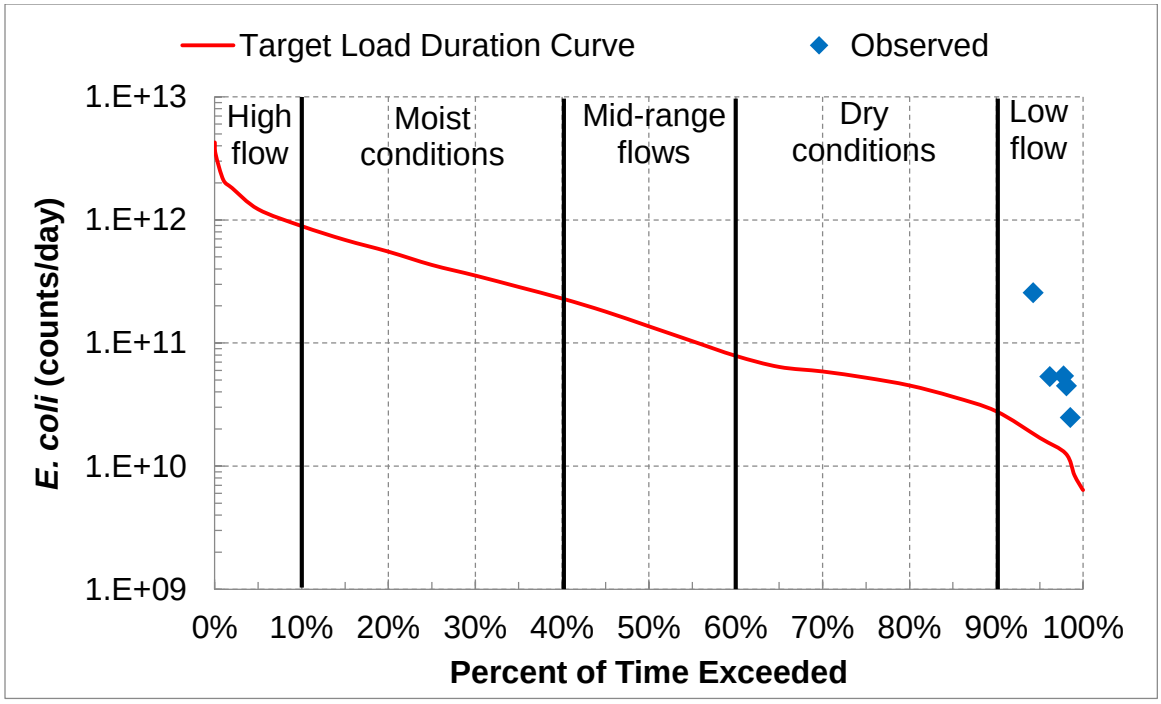


Figure F-40. *E. coli* loads and LDC for Fish Creek in *Cornell Ditch-Fish Creek* (*04 06) at the Indiana-Ohio state line.

F-3.2.3 Sources of Impairment

The potential sources of *E. coli* in this HU are evaluated in the following sections.[49]

F-3.2.3.1 Facilities with Individual NPDES Permits

Two facilities are covered by individual NPDES permits (see Figures C-3 in Appendix C for a map and Table F-8 for DMR data).

- **Hamilton Lake Conservancy District** (IN0050822; 300,000 gpd) is a sanitary POTW that serves the residential community around Hamilton Lake; it discharges to Hiram Sweet Ditch below Hamilton Lake and Baker Ditch. Monthly geometric means of *E. coli* concentrations were low (2 to 34 counts/100 mL, average 7 counts/100 mL) as were loads calculated from the geometric means (12 million to 300 million c/d, average 50 million c/d). Even under low flow conditions, 300 million c/d is an order of magnitude less than the LDC for *Hiram Sweet Ditch* (*04 03; Figure F-38). Thus, this facility is not a significant source of bacteria.

  The POTW land applied biosolids to two fields in the Fish Creek subwatershed in the 1980s and 1990s. One filed is 8 acres (directly adjacent to the POTW) and the other field is 41 acres. As the biosolids land application did not occur in the past decade, they are not considered a source of bacteria to the current impairments.

- **Hamilton Water Works** (IN0060216; 58,000 gpd) is a WTP that discharges to William Egbert Ditch, which is a tributary of Hiram Sweet Ditch upstream of Hamilton Lake. The WTP may not discharge bacteria and reports no bacteria DMR data. Daily maximum flow was low (0.005 to 0.062 cfs, average 0.029 cfs). Given its low effluent volumes and the fact that it's a WTP, the facility is not expected to be a significant source of bacteria.

F-3.2.3.2 Facilities Covered by General NPDES Permits

Two industrial facilities are permitted to discharge regulated stormwater in *Hiram Sweet Ditch* (*04 03).

F-3.2.3.3 On-Site Wastewater Treatment Systems

Except for the Hamilton Lake area, OWTS treat commercial and domestic wastewater. No permitted off-site discharging HSTS are in the Ohio-portion of this subwatershed. This subwatershed is mostly composed of crop fields and woodlots. Illicit cross-connections between OWTS and agricultural drain tiles are likely. Grandfathered or illicit off-site discharging OWTS, failing on-lot OWTS, and illicit OWTS connections to drain tiles likely contribute bacteria loads.

F-3.2.3.4 Livestock Operations

No CAFFs are in the Ohio-portion of the subwatershed and two CFOs are in the Indiana-portion of the subwatershed. Brand Farms is a CFO in the *Hiram Sweet Ditch* HU (*04 04) and Long Lane Farms Inc. is a CFO in the *Cornell Ditch-Fish Creek* HU (*04 06; see Figure C-6 and Table C-11). Aerial imagery shows that each CFO has containment ponds. Untreated livestock wastewater may not be discharged to surface streams but is a potential source of impairment during larger precipitation events that cause overland flow and runoff.

Within *Fish Creek* (HUC 0410003 04), SJRWI (2008a) observed livestock during windshield surveys at 14 locations in Ohio, at 76 locations in Steuben County, Indiana, and 50 locations in DeKalb County, Indiana; no livestock direct access to streams was observed and manure storage was observed at two locations in DeKalb County. Most operations were small (<10 animals). No additional information about

[49] No communities with CSOs or SSOs or regulated MS4s are in this subwatershed.

hobby farms and small livestock operations are available. Thus, livestock in Ohio and Indiana may contribute to the nutrient impairment.

F-3.2.3.5 Crop Productions

Fish Creek and its tributaries flows through and along row crop fields and woodlots. Manure application to cropland, including tiled cropland, is a potential source of *E. coli* to the impaired segments in the Fish Creek subwatershed.

In the 1980s and 1990s, the Angola Municipal STP, Apollo Disposal Inc., and Hamilton Lake Conservancy District land applied WWTP sludge to crop fields in the *Fish Creek* HU (Table C-10); while IDEM provided field locations, application dates, methods, and rates data are sparse. As biosolids application has not occurred in this HU during the last decade, biosolids are not considered a source of RU impairment.

- Biosolids from the Angola Municipal STP were land applied to 20 fields (807 acres) in the *West Branch Fish Creek* HU (*04 01); except for 4 applications in August 2003, no applications occurred in this HU since 1995.
- In the *Hiram Sweet Ditch* HU (*04 03) during the 1990s, three entities land applied biosolids to one field each: the Angola Municipal WTP (37 acres), Apollo Disposal Inc. (3 acres), and the Hamilton Lake Conservancy District (8 acres).

F-3.3 Sol Shank Ditch-St. Joseph River (HUC 04100003 05)

F-3.3.1 Monitoring Data

Ohio EPA collected 5 samples from one site on Big Run and 5 or 10 samples from the SJR (Table F-5), while IDEM collected 5 samples from one site on Big Run and 2 samples from one site on the SJR (Table F-6). *E. coli* in Big Run ranged from 78 to 1,210 counts/100 mL with a geometric mean of 290 counts/100 mL; this site was on a segment in non-attainment of its RU. *E. coli* in the SJR was 230 and 260 counts/100 mL; there were insufficient data to assess RU attainment on the SJR.

F-3.3.2 Load Duration Curve

A LDC was developed for Big Run (Figure F-41) and *E. coli* data collected by IDEM in 2005 are displayed as loads[50]. To achieve the TMDL (i.e., reduce loads to the LDC), reductions on a per sample basis, for the three samples that exceed the TMDL target, range from 12 to 81 percent.

[50] *E. coli* concentrations from IDEM samples were multiplied by SWAT-simulated flows and converted to appropriate units.

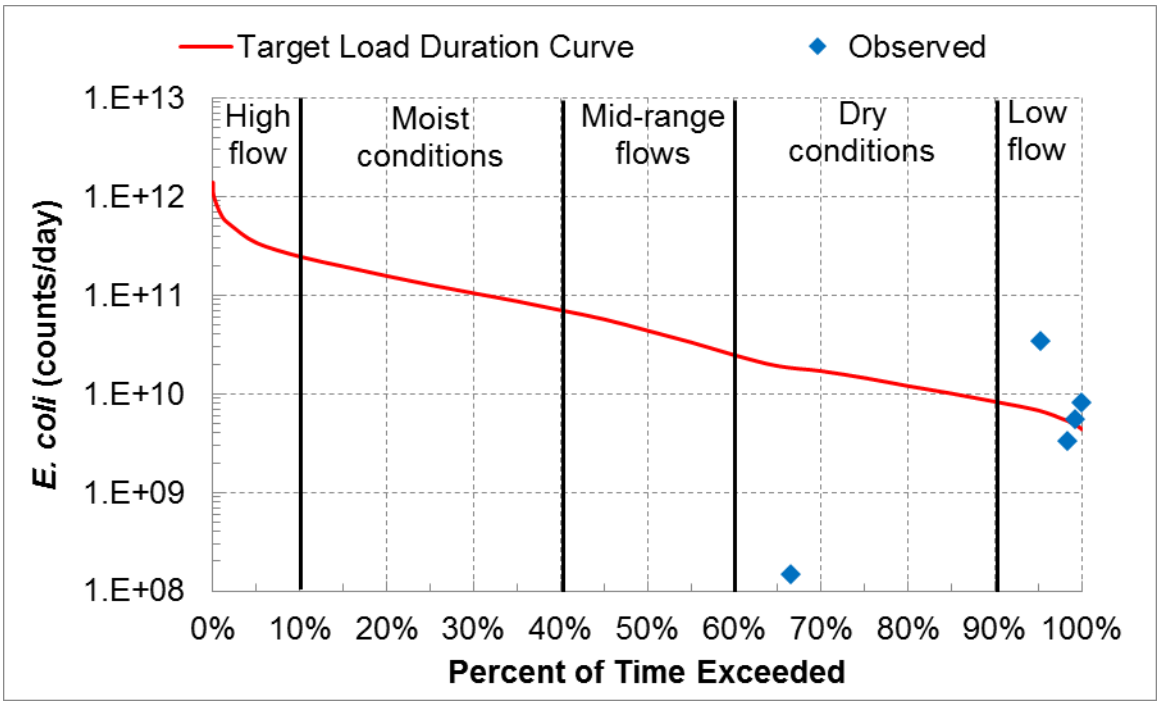


Figure F-41. *E. coli* loads and LDC for *Big Run* (*05 02) at the Indiana-Ohio state line.

F-3.3.3 Sources of Impairment

The potential sources of *E. coli* in this HU are evaluated in the following sections.

F-3.3.3.1 Industrial Facilities with Individual NPDES Permits

Two industrial facilities are covered by individual NPDES permits (see Figures C-2 and C-3 in Appendix C for maps). Neither facility is permitted to discharge bacteria nor considered to be sources of impairment.

- **Edgerton WTP** (2IZ00040; stormwater) is "is an ion exchange and iron-manganese removal water treatment facility" with "filter backwash and softener regeneration wastes" discharged to the St. Joseph River (Ohio EPA 1994, p. 19). The NPDES permit identifies storm sewers as the receiving waterbody. The WTP discharged 0.009 cfs 99 percent of the days from 2007 through 2013. As the facility is not permitted to discharge bacteria and almost always discharges very small effluent volumes, it is not a source of impairment.
- **Steel Dynamics, Inc.** (IN0059021; 144,000 gpd) discharges industrial and sanitary wastewater to the Butler WWTP (under Butler's pretreatment program); it also discharges non-contact cooling water, boiler blowdown water, boiler condensate, other industrial wastewater, and industrial stormwater to Sol Shank Ditch. Industrial stormwater may contain bacteria, whereas the other waste-streams should not contain bacteria. As Sol Shank Ditch attains its RU, the facility is not a source of impairment.

F-3.3.3.2 Public Facilities with Individual NPDES Permits

Two public facilities are covered by individual NPDES permits (see Figures C-2 and C-3 in Appendix C for maps and Table F-7 for DMR data). Both facilities are sanitary POTWs with SSOs; both WWTPs are sources of bacteria load.

- **Butler WWTP** (IN0022462, 2 mgd) is a sanitary POTW that discharges to Big Run. Effluent flows vary from 1.0 to 2.8 cfs (average 1.7 cfs) with low *E. coli* concentrations (2 to 23 counts/100 mL, average 7 counts/100 mL). *E. coli* loads ranged from 51 million to 1.5 billion c/d, average 258 million c/d. Only during low-flow conditions would the maximum effluent load be the dominant source of *E. coli* loading to Big Run. During most flow conditions, the WWTP contributes relatively small, insignificant, *E. coli* load to Big Run.

  Butler is a CSO community. The city has one CSO outfall on Big Run (003) that discharged in 2008 through 2014 (Table C-6 in Appendix C). Overflow volumes (<0.1 to 3.0 cfs, average 2.5 cfs), as compared to the Big Run were relatively small in the high flow through mid-range flow zones of Big Run, but CSO volumes would become the dominant flow by volume in the dry conditions and low flow zones. Despite relatively small flow volumes, bacteria concentrations of untreated combined waste were likely extremely elevated, which could yield large CSO bacteria loads. As discussed in Section 4.2.2.1 of the main report, Butler will reduce to six CSOs per year from its single outfall. The city has contributed to the localized impairment on Big Run and could continue to do so.

- **Edgerton WWTP** (2PB00047; 200,000 gpd) is a sanitary POTW that discharges to the SJR. The WWTP is composed of three facultative lagoons that were constructed in 1991; the WWTP serves a community with fully separated storm and sanitary sewers (Ohio EPA 1994, p. 10). Effluent volumes vary considerably (0.3 to 6.3 cfs, average 2.6 cfs), while fecal coliform concentrations (1 to 1,600 counts/100 mL, average 247 counts/100 mL) and loads (43 million to 56 billion c/d, average 12 billion c/d) are often high. Only a few upstream/downstream DMR data were collected and no pattern is apparent except that upstream concentrations are always considerably higher than effluent concentrations. Effluent flow volumes and *E. coli* load are typically several orders of magnitude less than the SJR. While the WWTP does contribute *E. coli* load to the SJR, the WWTP is not a significant source.

  Edgerton is a SSO community. The city reported zero SSOs per month from October 2006 through December 2007; no other data indicate any SSOs have occurred in recent years. Given the lack of recent SSOs, Edgerton SSOs did not cause the RU impairment. Future SSOs are a potential source, but they are illicit and would be addressed through Ohio EPA's NPDES program.

F-3.3.3.3 Facilities Covered by General NPDES Permits

Twelve facilities are covered by general NPDES permits[51]. According to the general permits (IDEM 2014b) for the two permittees below, such facilities are not allowed to discharge bacteria. Therefore, they are not considered a source of RU impairment.

- **Eastside High School** (ING250077) discharges NCCW to Butler's storm sewers that drain to Big Run.
- **Stafford Gravel Inc.** (ING490043) is a dimension stone and crushed stone that discharges to Christoffel Ditch.

Four facilities in Ohio and six facilities in Indiana are covered by the general permits for stormwater associated with industrial activities.

[51] The following four permits were terminated: Citation Bohn Aluminum (IN0000515; NCCW and stormwater), DeKalb County East Community School District (IN0055808), DeKalb Molded Plastics Company (IN0051659), and Universal Tool and Stamping Company (IN0000639; rinse water).

F-3.3.3.4 On-Site Wastewater Treatment Systems

Except for the city of Butler and village of Edgerton, OWTS treat commercial and domestic wastewater. No permitted off-site discharging HSTS are in the Ohio-portion of this subwatershed. This subwatershed is mostly composed of crop fields and woodlots. Illicit cross-connections between OWTS and agricultural drain tiles are likely. Grandfathered or illicit off-site discharging OWTS, failing on-lot OWTS, and illicit OWTS connections to drain tiles likely contribute bacteria loads.

F-3.3.3.5 Livestock Operations

No CAFFs are in the Ohio-portion of the subwatershed and one CAFO and three CFOs are in the Indiana-portion of the subwatershed (see Figure C-6 and Table C-11). Except for R&D Malcolm Farms, aerial imagery shows that the CAFO and each CFO have containment ponds. Untreated livestock wastewater may not be discharged to surface streams but is a potential source of impairment during larger precipitation events that cause overland flow and runoff.

- **Don Hook Farms, Incorporated** is a CFO with 246 sows and 320 nursery pigs that is near Peter Grube Ditch, a direct tributary to the SJR (*05 05).
- **Irish Acres Dairy, LLC** is a CAFO with 1,196 dairy cattle in the Haverstock Ditch subwatershed, which is tributary to Big Run (*05 02).
- **KD Carnahan Farms, Inc.** is a CFO with 280 dairy heifers, 204 dairy cattle, and 70 dairy calves that is immediately adjacent to Hardwood Ditch, which is tributary to Buck Creek (*05 04).
- **R&D Malcolm Farms, Incorporated** is a CFO with 125 sheep in the Mason Ditch subwatershed, which is tributary to Buck Creek (*05 04).

A non-permitted livestock operation on County Road 6 northeast of the village of Edgerton, Ohio is visible in aerial imagery at GoogleEarth™. The livestock operation includes three large barns; an analysis of historic GoogleEarth™ aerial imagery shows that two of long barns were built between December 2006 and August 2009 and the first long barn was built prior to April 1994.

Within *Sol Shank Ditch-St. Joseph River* (HUC 04100003 05), SJRWI (2008a) observed livestock during windshield surveys at 39 locations in Williams County, Ohio, at 35 locations in Defiance County, Ohio, and 145 locations in Indiana; manure storage was observed at one site in Defiance County and livestock in a stream were observed at another site in Defiance County. No additional information about hobby farms and small livestock operations are available. Thus, livestock in Ohio and Indiana may contribute to the nutrient impairment.

F-3.3.3.6 Crop Production

The SJR, Bear, Eagle, and Nettle creeks, and their tributaries flows through and along row crop fields and woodlots. Manure application to cropland, including tiled cropland, is a potential source of *E. coli* to the impaired segments.

Biosolids from Steel Dynamics, Inc. were land applied to 5 fields (87 acres) in the *Hoodelmier Ditch-St. Joseph River* HU (*05 06). All 5 fields are adjacent to or nearby the Steel Dynamics facility. No data regarding the dates, rates, or methods of application area available. Biosolids application are assumed not to have occurred during the last decade; therefore, biosolids are not considered a source of RU impairment.

F-3.4 Mason Ditch-Cedar Creek (HUC 04100003 06)

F-3.4.1 Monitoring Data

IDEM collected 5 or 6 samples from 5 sites on Cedar Creek and 5 sites on its tributaries (Table F-6). *E. coli* in Cedar Creek ranged from 10 to 25,000 counts/100 mL with geometric means at the 5 sites ranging from 247 to 1,499 counts/100 mL; all of the 5 sites were on segments that did not attain their RU. *E. coli* in the tributaries ranged from 20 to 1,300 counts/100 mL with geometric means at the 5 sites ranging from 155 to 937 counts/100 mL; four sites were on segments that did not attain their RU and one site was on a segment with insufficient data to assess RU attainment.

F-3.4.2 Load Duration Curves

LDCs were developed for the three HUC12s with segments impaired for their RUs: Figure F-42, Figure F-43, and Figure F-44. *E. coli* data collected by IDEM in 2000 are not displayed as loads due to a lack of flow data[52].

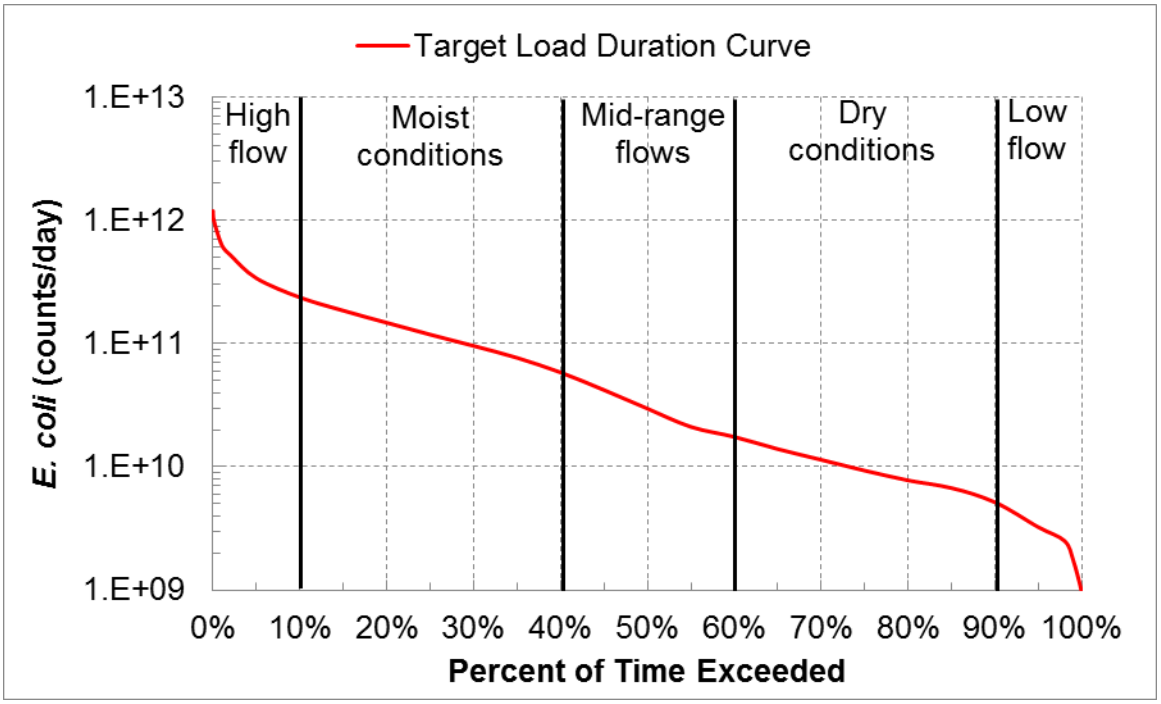


Figure F-42. *E. coli* LDC for Cedar Creek in *Cedar Lake-Cedar Creek* (*06 01) at the HU outlet.

[52] The SWAT model was developed to simulate calendar years 2004 through 2014.

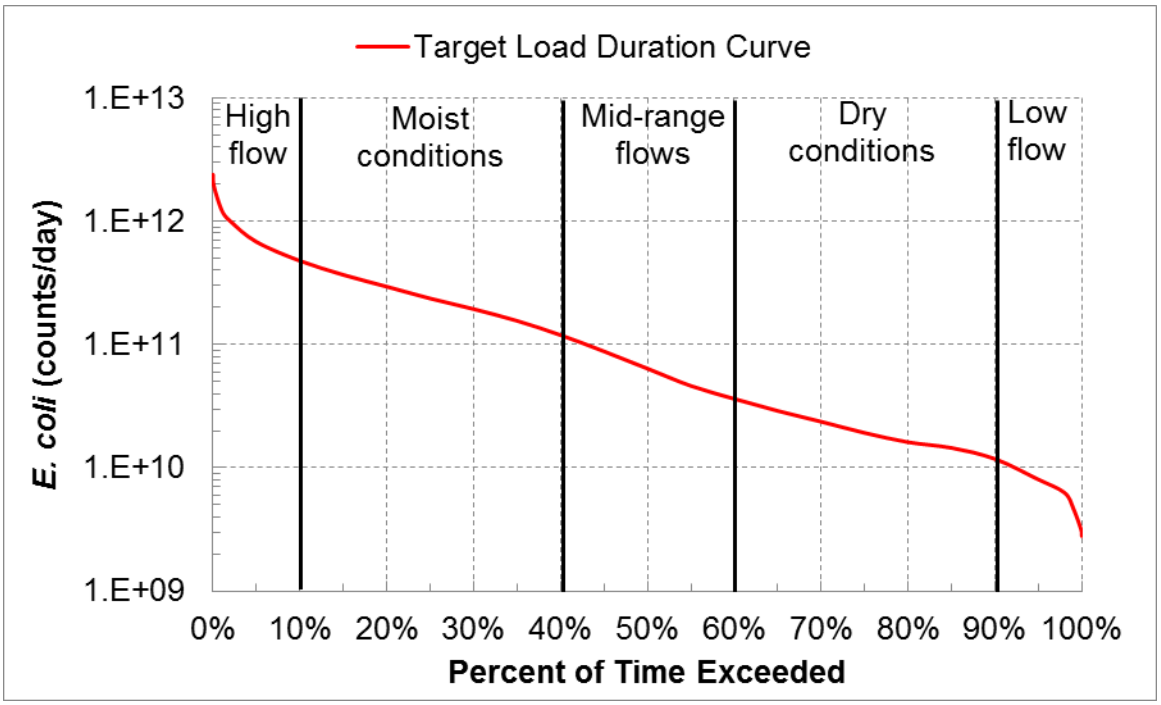


Figure F-43. *E. coli* LDC for Cedar Creek in *Dibbling Ditch-Cedar Creek* (*06 02) at the HUC12 outlet.

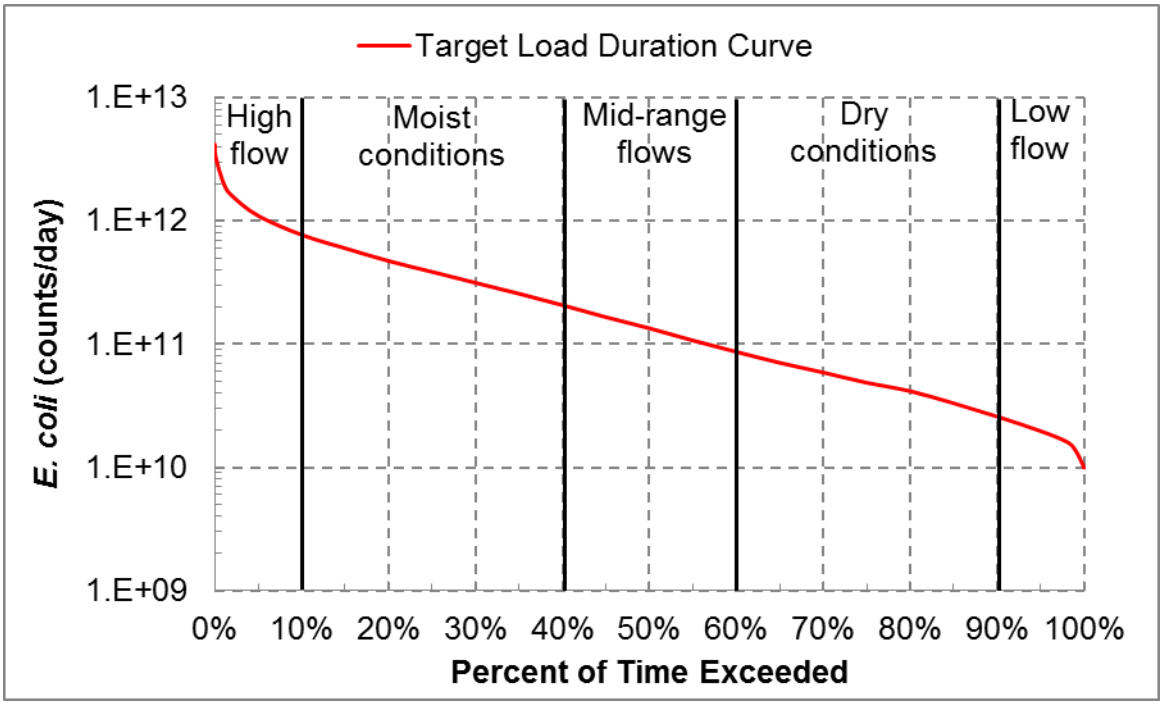


Figure F-44. *E. coli* LDC for Cedar Creek in *Smith Ditch-Cedar Creek* (*06 02) at the HUC12 outlet.

F-3.4.3 Sources of Impairment

The potential sources of *E. coli* in this HU are evaluated in the following sections.

F-3.4.3.1 Industrial Facilities with Individual NPDES Permits

Four industrial facilities are covered by individual NPDES permits[53] (see Figures C-3 and C-4 in Appendix C for maps). None of the facilities are permitted to discharge bacteria. While bacteria may be picked up by stormwater, none of these facilities are considered to be significant sources of bacteria.

- **Auburn Gear Inc.** (IN0000566; 100,000 gpd) discharges NCCW and stormwater through two outfalls to Cedar Creek.
- **Contech U.S., LLC** (IN0046043; 580,000) discharges NCCW and stormwater through 4 outfalls to Grandstaff Ditch.
- **Rieke Packaging Systems** (IN0000868; 760,000 gpd) discharges NCCW and stormwater to Cedar Creek.
- **Tower Automotive USA II** (IN0046761; 150,000 gpd) discharges industrial wastewater to Grandstaff Ditch.

F-3.4.3.2 Public Facilities with Individual NPDES Permits

Three public facilities are covered by individual NPDES permits (see Figures C-3 and C-4 for maps and Table F-8 for DMR data).

- **Auburn WWTP** (IN0020672, 4.5 mgd) is a sanitary POTW that discharges to Cedar Creek. Effluent flows vary from 1.5 to 5.0 cfs (average 2.7 cfs) with typically low *E. coli* monthly geometric means (2 to 233 counts/100 mL, average 30 counts/100 mL). *E. coli* loads ranged from 155 million to 21 billion c/d, average 2.6 billion c/d. Auburn WWTP's average *E. coli* load is one or more orders of magnitude less than the LDC for Cedar Creek; only during low flow conditions would the maximum effluent load become the dominant source of flow and bacteria.

  Auburn is a CSO community (refer to Section 4.2.2.1 of the main report). The city has 5 CSO outfalls that discharged in 2010 through 2014 (Table C-6 in Appendix C). Overflow volumes (CSOs: <0.1 to 4.7 cfs), as compared to the Cedar Creek were relatively small in the high flow through dry conditions flow zones of Cedar Creek, but CSO volumes would become the dominant flow by volume in the drier portion of the low flow zone. Despite relatively small flow volumes, bacteria concentrations of untreated combined waste were likely extremely elevated. Similarly, overflows (CSO outfall 010: <0.005 cfs) were orders of magnitude less than flows in John Diehl Ditch.

- **Waterloo Municipal STP** (IN0020711; 240,000 gpd) is a sanitary POTW that discharges to the Cedar Creek. Effluent volumes were fairly consistent (0.2 to 1.1 cfs, average 0.5 cfs), while *E. coli* concentrations (1 to 868 counts/100 mL, average 20 counts/100 mL) and loads (4.4 million to 12.6 billion c/d, average 285 million c/d) are occasionally high. Except for the spring of 2014, no monthly geometric mean exceeded 125 counts/100 mL. While average E. coli loads are typically one or more orders of magnitude less than the LDC for Cedar Creek (*06 02), the maximum *E. coli* load exceeds the LDC across the low flow zone and part of the dry conditions flow zone. Therefore, only if it discharges high effluent volumes during in-stream lower flow conditions would the Waterloo Municipal STP become a major source of impairment.

[53] The following four permits were terminated: Auburn Foundry, Inc. Plant #1 (IN0053651; NCCW), Auburn Foundry, Inc. Plant 1 (IN0061255), Cooper Tire and Rubber Company (IN0000361; NCCW), and Dana Corp. Spicer Clutch Div. (IN0000370; NCCW).

- **Waterloo Public Water Supply** (IN0049433) was a WTP that formerly discharged to a county drain tributary to Cedar Creek. As the WTP should not have discharged bacteria and its effluent volumes were very small, the WTP was not a source of bacteria impairment.

F-3.4.3.3 Facilities Covered by General NPDES Permits

Nine facilities and one MS4 are covered by general NPDES permits[54]. Portions of the city of Auburn (INR040119) are a regulated as an MS4; such areas exclude the sewersheds draining the CSS.

F-3.4.3.4 On-Site Wastewater Treatment Systems

Except for the city of Auburn and town of Waterloo, OWTS treat commercial and domestic wastewater. While this subwatershed does contain some urban development, much of the land area is composed of crop fields and woodlots. Illicit cross-connections between OWTS and agricultural drain tiles are likely. Grandfathered or illicit off-site discharging OWTS, failing on-lot OWTS, and illicit OWTS connections to drain tiles likely contribute bacteria loads.

F-3.4.3.5 Livestock Operations

One CAFO and no CFOs are in this subwatershed (see Section 4.2.3 of the main report and Figure C-6 in Appendix C). Phillips Farm is a CAFO with 170 dairy calves and 1,950 dairy heifers that is in the Swartz Ditch subwatershed, which is a tributary of Cedar Creek (*06 01). Aerial imagery shows that the CAFO has containment ponds. Untreated livestock wastewater may not be discharged to surface streams but is a potential source of impairment during larger precipitation events that cause overland flow and runoff.

Within *Matson Ditch-Cedar Creek* (HUC 04100003 06), SJRWI (2008a) observed livestock during windshield surveys at 136 locations; no manure storage was observed and livestock in a stream were observed at one site. No additional information about hobby farms and small livestock operations are available. Thus, livestock may contribute to the nutrient impairment.

F-3.4.3.6 Crop Production

Cedar Creek, Dibbling, Mason, Smith, and Swartz ditches, and their tributaries flows through and along row crop fields and woodlots. Manure application to cropland, including tiled cropland, is a potential source of *E. coli* to the impaired segments.

Biosolids were land applied to fields in each of the 12-digit HUs in this subwatershed:

- *Cedar Lake-Cedar Creek* (*06 01): Auburn WWTP (1 field, 15 acres)
- *Dibbling Ditch-Cedar Creek* (*06 02): Auburn WWTP (8 fields, 142 acres), Kendallville Municipal STP (1 field, 2 acres), Waterloo Municipal STP (7 fields, 108 acres)
- *Mason Ditch* (*06 03): Auburn WWTP (1 field, 2 acres)
- *Smith Ditch-Cedar Creek* (*06 04): Auburn WWTP (11 fields, 328 acres)

While IDEM provided field locations, biosolids application dates, methods, and rates data are sparse (Table C-10). Since biosolids application has not occurred in this HU during the last decade, biosolids are not considered a source of RU impairment. Historically, biosolids land application may have contributed to bacteria impairments to waterbodies in this HU. For example, Schwartz Ditch flows through crop fields with land application of biosolids, while Cedar Creek and an unnamed tributary to Dibbling Ditch flow directly adjacent to crop fields with land application.

[54] The following two permits were terminated: Auburn Foundry, Inc. Plant #1 (ING250020; NCCW), Eaton Corp. Clutch Division (ING250048; NCCW) and Marathon Oil. Co. (ING340018; petroleum products terminal). Neither facility was allowed to discharge bacteria; therefore, neither facility was an historic source of bacteria impairment.

F-3.5 Cedar Creek (HUC 04100003 07)

F-3.5.1 Monitoring Data

IDEM collected 5 to 9 samples from 4 sites on Cedar Creek, 4 to 6 samples from 3 sites on Little Cedar Creek, and 5 or 6 samples from 6 sites on their tributaries (Table F-6).

- **Cedar Creek:** concentrations ranged from 5 to 6,867 counts/100 mL with geometric means at the 4 sites ranging from 236 to 873 counts/100 mL; 3 sites were on segments that did not attain their RU and 1 site was on a segment that had insufficient data to assess RU attainment.
- **Little Cedar Creek:** concentrations ranged from 104 to 2,419 counts/100 mL with geometric means at the 3 sites ranging from 378 to 639 counts/100 mL; all of the 3 sites were on segments that did not attain their RU.
- **Tributaries:** concentrations ranged from 29 to 19,863 counts/100 mL with geometric means at the 6 sites ranging from 64 to 7,196 counts/100 mL; 4 sites were on segments that did not attain their RU and 2 sites were on segments that had insufficient data to assess RU attainment.

F-3.5.2 Load Duration Curves

LDCs were developed for the five HUC12s with segments impaired for their RUs: Figure F-45, Figure F-46, Figure F-47, Figure F-48, and Figure F-49. *E. coli* data collected by IDEM in 2005 and 2010 are displayed as loads[55] in some LDC figures. Data collected in 2000 and 2001 are not displayed because loads could not be calculated due to a lack of flow data[56].

Some loads exceeded the LDCs. To achieve the TMDLs (i.e., reduce loads to the LDCs), reductions on a per sample basis range from 94 to 99 percent for three samples collected from Peckhart Ditch; seven samples were below the LDC. For Black Creek, all five loads exceeded the LDC and required reductions of 71 to 88 percent.

[55] *E. coli* concentrations from IDEM samples were multiplied by SWAT-simulated flows and converted to appropriate units.
[56] The SWAT model was developed to simulate calendar years 2004 through 2014.

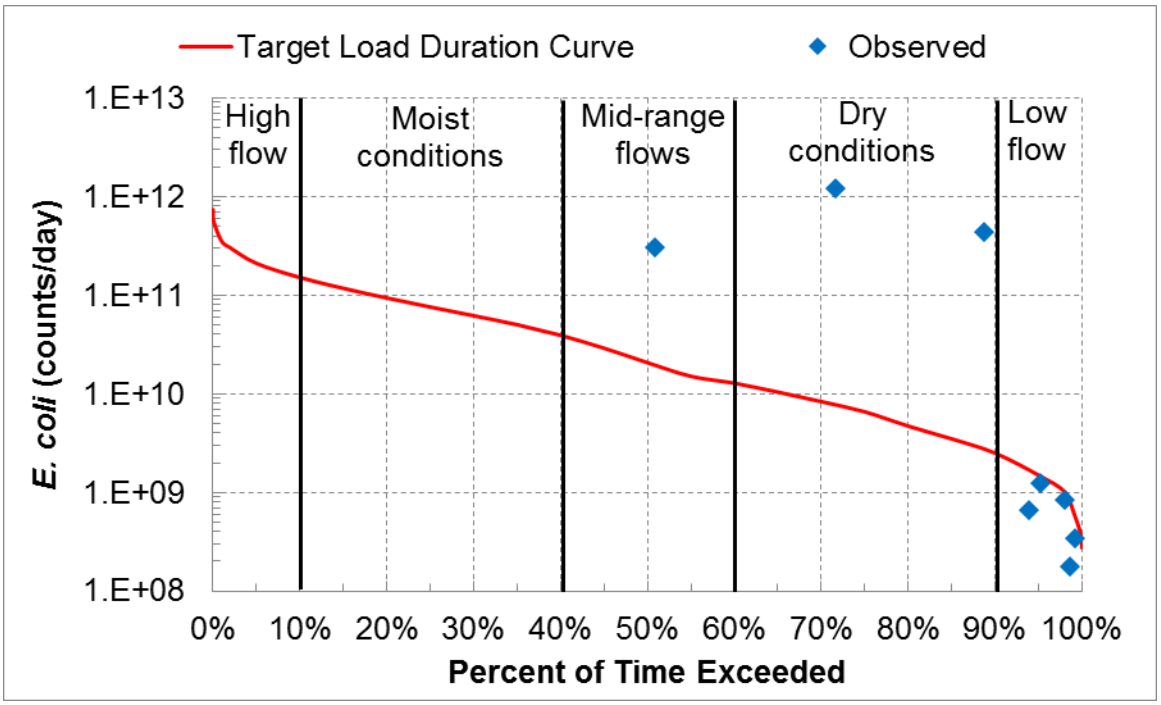


Figure F-45. *E. coli* loads and LDC for Peckhart Ditch in *Peckhart Ditch-John Diehl Ditch* (*07 02) at the confluence of Peckhart Ditch with John Diehl Ditch.

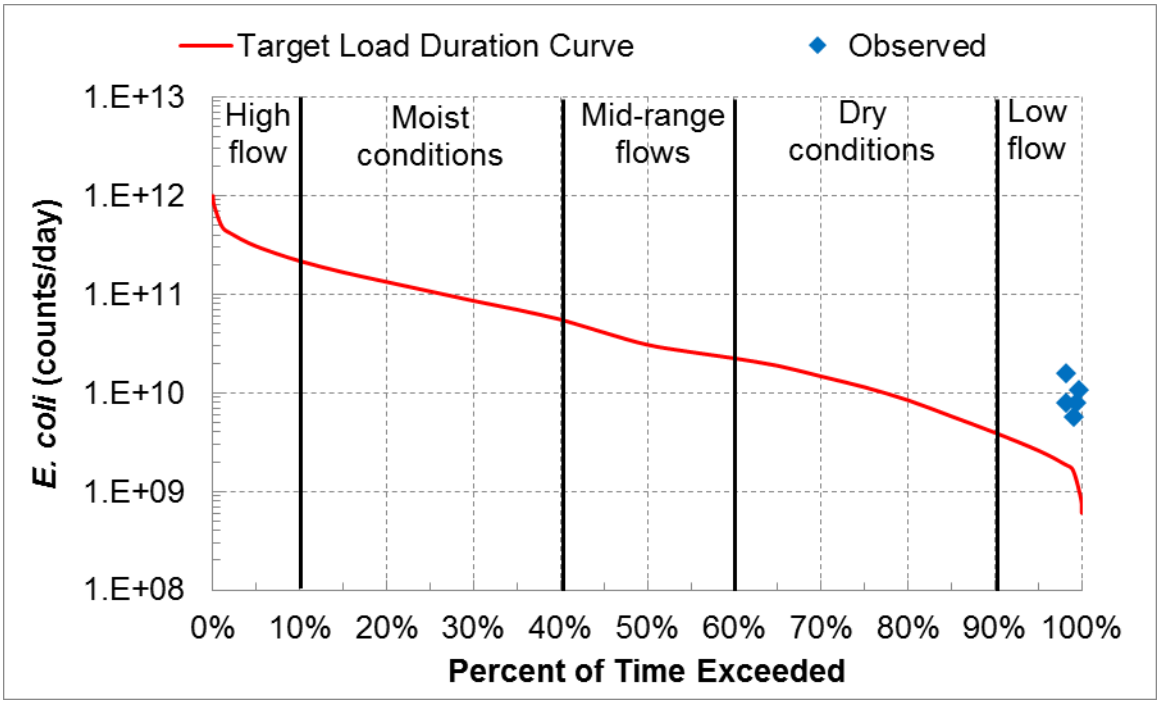


Figure F-46. *E. coli* loads and LDC for Black Creek in *Black Creek* (*07 04) at the HU outlet.

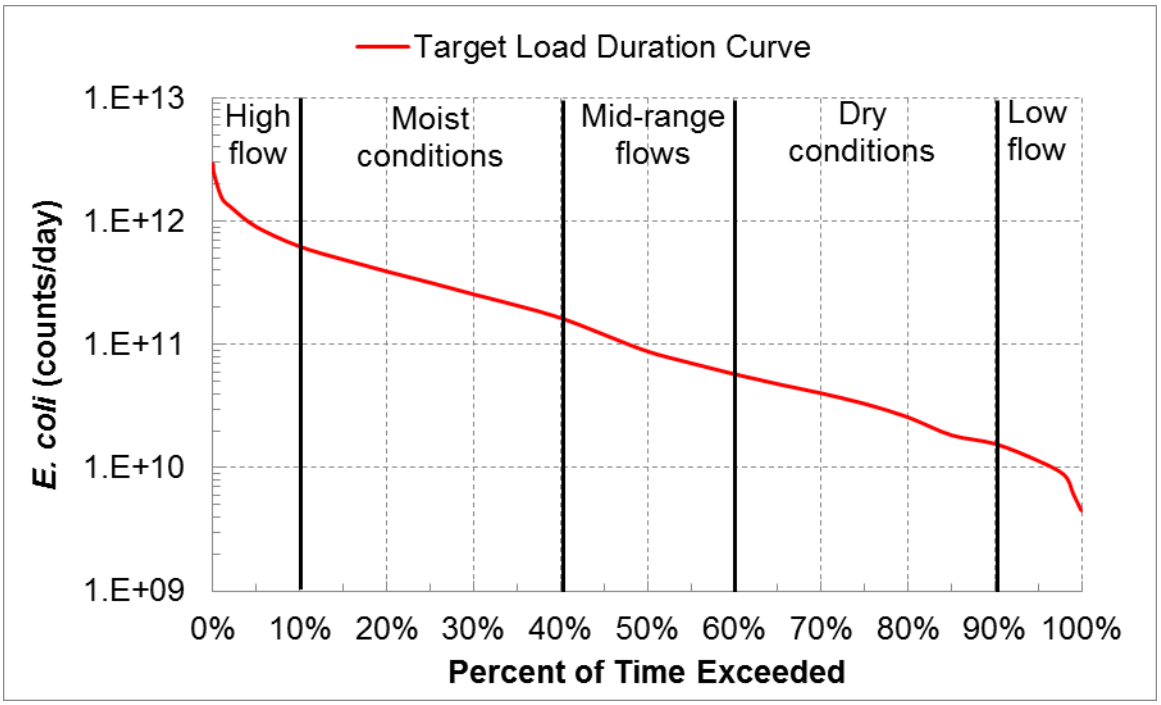


Figure F-47. *E. coli* LDC for Little Cedar Creek in *King Lake-Little Cedar Creek* (*07 05) at the HUC12 outlet.

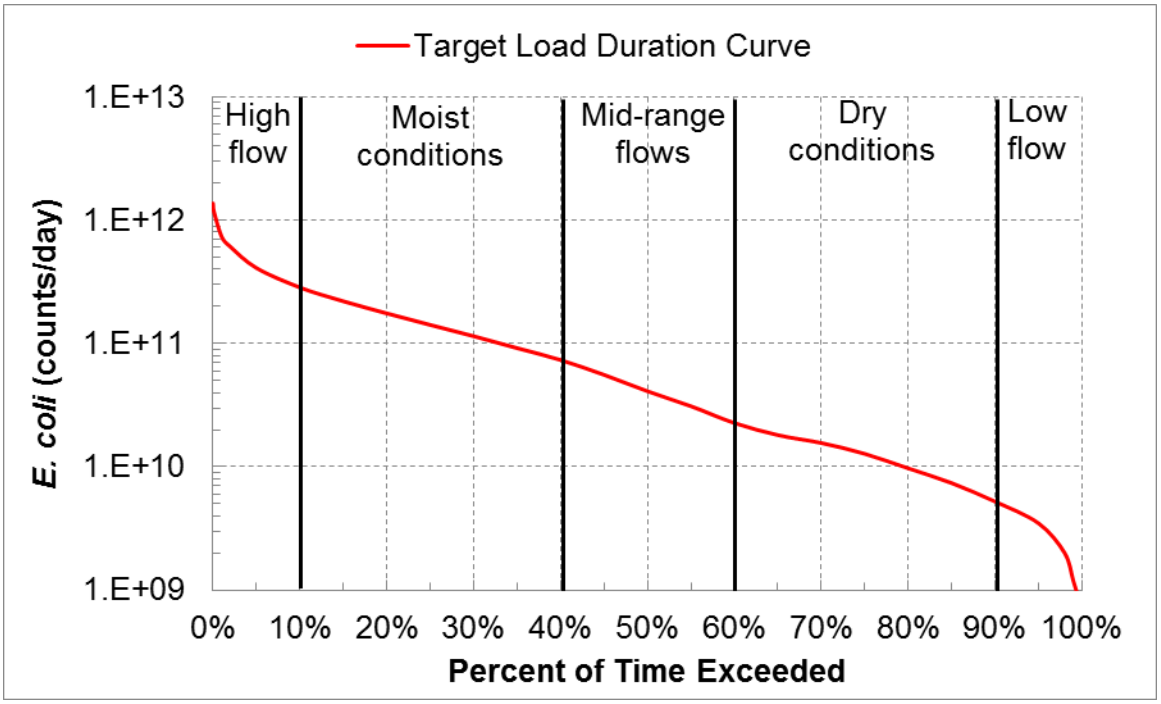


Figure F-48. *E. coli* LDC for Willow Creek in *Willow Creek* (*07 06) at the HUC12 outlet.

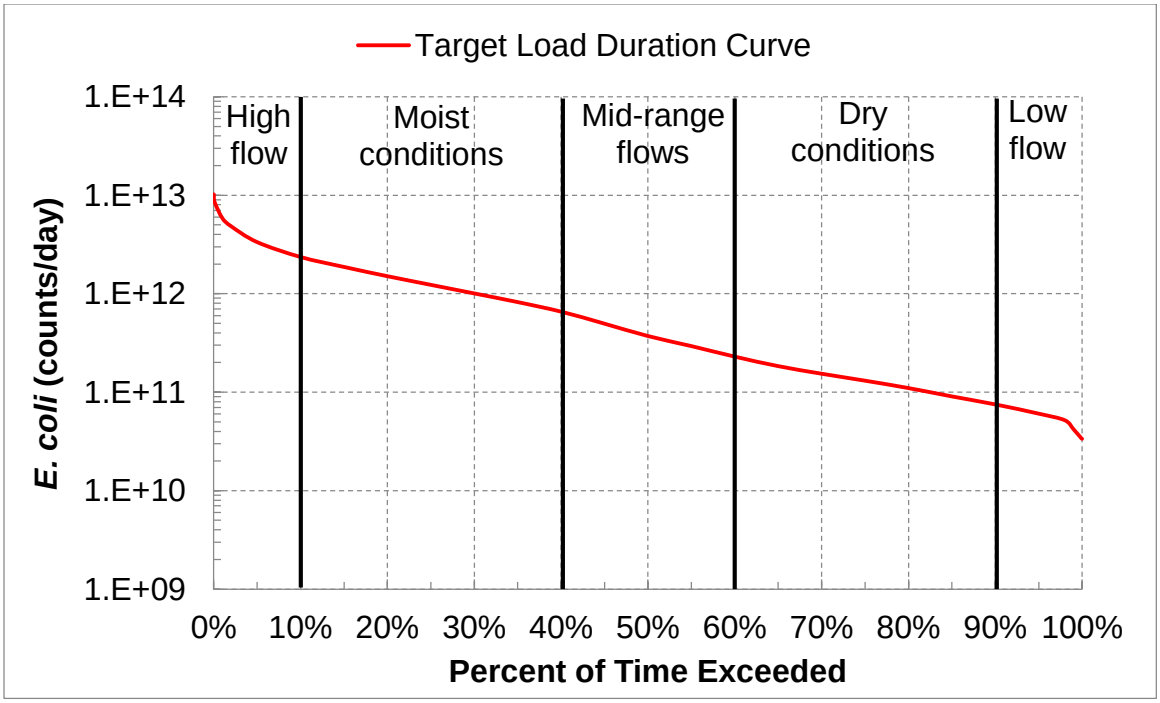


Figure F-49. *E. coli* LDC for Cedar Creek in *Dosch Ditch-Cedar Creek* (*07 07) at the HUC12 outlet.

F-3.5.3 Sources of Impairment

The potential sources of *E. coli* in this HU are evaluated in the following sections.

F-3.5.3.1 Facilities with Individual NPDES Permits

Six facilities are covered by individual NPDES permits[57] (see Figures C-3 and C-4 for maps and Table F-8 for DMR data). At the four WWTPs, geometric means of effluent loads were typically several orders of magnitude less than in-stream loads in the high flow through mid-range flow conditions. Effluent loads at elevated concentrations may be contributing significantly to in-stream loads in the low flow zone. Because the effluent DMR does not include raw data, it is not possible to determine if the extremely elevated in-stream concentrations during low flow conditions are due to effluent discharges.

- **Avila Water Department** (IN0052035, 0.034 mgd) is a WTP that discharges to an unnamed tributary of Kings Lake. This WTP is not permitted to discharge bacteria, and thus, is not a source of impairment.
- **Avila WWTP** (IN0020644, 0.2) is a sanitary POTW that discharges to an unnamed tributary of Kings Lake. Effluent flows varied (0.05 to 0.82 cfs, average 0.53 cfs), while monthly geometric mean *E. coli* concentrations were low (1 to 29 counts/100 mL, average 7 counts/ 100 mL) and loads varied (5.1 to 353 million c/d, average 88 million c/d).
- **Corunna WWTP** (IN0047473, 0.024 mgd) is a sanitary POTW that discharges to an unnamed tributary of John Diehl Ditch. Effluent volumes vary considerably (0.002 to 0.600 cfs, average 0.037 cfs), while monthly geometric mean *E. coli* concentrations are very high (1 to 36,260 counts/100 mL, average 1,272 counts/100 mL), and *E. coli* loads vary considerably (1.6 million to 9.8 billion c/d, average 492 million).

[57] The following five permits were terminated: Auburn Foundry Landfill (IN0061590), Auburn Rest Area I-69 North (IN0038504), Auburn Rest Area I-69 South (IN0038491), Huntertown WWTP (IN0023116), and Wawasee Sewer and Water (IN0042561).

- **Garrett WWTP** (IN0029969, 1.2 mgd) is a sanitary POTW that discharges to Garrett City Ditch. Effluent volumes were fairly consistent (0.7 to 1.9 cfs, average 1.1 cfs), while monthly geometric mean *E. coli* concentrations were generally low (1 to 60 counts/100 mL, average 15 counts/100 mL) and loads varied (19 million to 2.0 billion c/d, average 382 million c/d).
- **Indian Springs Rec Campground** (IN0032107, 0.04 mgd) is a sanitary POTW that discharges seasonally to Little Cedar Creek. Effluent volumes were low (0.001 to 0.046 cfs, average 0.008 cfs) while monthly geometric mean *E. coli* concentrations were often high (1 to 2,000 counts/100 mL, average 162 counts/100 mL) and loads varied considerably (12 thousand to 478 million c/d, average 33 million c/d). The campground always discharges several orders of magnitude less than the LDC. While this facility contributes *E. coli* load to Little Cedar Creek, its load is relatively insignificant.
- **La Otto Regional Sewer District** (IN0058611, 0.05 mgd) is a sanitary POTW that discharges to Black Creek. Effluent volumes varied considerably (0.002 to 0.788 cfs, average 0.122 cfs) while monthly geometric mean *E. coli* concentrations were often high (6 to 1,720 counts/100 mL, average 318 counts/100 mL) and loads varied considerably (12 million to 18 billion c/d, average 3.4 billion c/d).
- **Metal Technologies** (IN0061263; 200,000 gpd)[58] is an industrial facility that discharges NCCW and industrial stormwater to Diehl Ditch. Effluent volumes varied considerably (<0.01 to 0.37 cfs, average 0.05 cfs). Effluent is not evaluated for *E. coli*. This facility's NCCW is not a source of *E. coli*, and its industrial stormwater is likely a negligible source of bacteria.

F-3.5.3.2 Facilities Covered by General NPDES Permits

Benchmark Distribution Terminals (ING340037) is covered by Indiana's general permit for petroleum distribution terminals; the facility is permitted to discharge industrial stormwater. Nine industrial facilities and one MS4 are covered by general NPDES permits[59]. Portions of the city of Auburn (INR040119) are a regulated as an MS4; such areas exclude the sewersheds draining the CSS.

F-3.5.3.3 On-Site Wastewater Treatment Systems

Except for the cities of Auburn and Garrett, towns of Avila and Corunna, and unincorporated community of La Otto, OWTS treat commercial and domestic wastewater. Portions of this subwatershed are developed; other portions are composed of crop fields and woodlots. Illicit cross-connections between OWTS and agricultural drain tiles are possible. Grandfathered or illicit off-site discharging OWTS, failing on-lot OWTS, and illicit OWTS connections to drain tiles likely contribute bacteria loads.

F-3.5.3.4 Livestock Operations

One CAFO and one CFO are in this subwatershed (see Section 4.2.3 of the main report and Figure C-6 in Appendix C). Sunrise Heifer Farm LLC is a CAFO with 2,650 dairy heifers that drains to an unnamed ditch in the Peckhart Ditch subwatershed (*07 02). Haynes Dairy Farm is a DVO with 264 sows and 400 nursery pigs that drains to Ober Ditch (the western and southern boundary of the property), which is tributary to Peckhart Ditch (*07 02). Untreated livestock wastewater may not be discharged to surface streams but is a potential source of impairment during larger precipitation events that cause overland flow and runoff.

[58] Metal Technologies (IN0061263) is located at the same address as the former Auburn Foundry Landfill (IN0061590). Adjacent grassed areas, ponds, and wetlands that are associated with Metal Technologies appear to discharge to *Dosch Ditch-Cedar Creek* (*07 07).

[59] The permit for Auburn Foundry, Inc. Plant #2 (ING250019; NCCW) was terminated. The facility was not allowed to discharge bacteria; therefore, it was not an historic source of bacteria impairment.

Within *Dibbling Ditch-Cedar Creek* (HUC 04100003 07), SJRWI (2008a) observed livestock during windshield surveys at 133 locations in DeKalb County and at 149 locations in Noble County; manure storage was observed at 4 locations in DeKalb County. No additional information about hobby farms and small livestock operations are available. Thus, livestock may contribute to the nutrient impairment.

F-3.5.3.5 Crop Production

Cedar, Little Cedar, Black, and Sycamore creeks; Dosch, Garrett City, and John Diehl ditches; and their tributaries flow through and along row crop fields and woodlots. Lower Cedar Creek flows through wooded areas and its tributaries mostly drain rural and suburban residential properties (with a few agricultural areas) on the fringes of the Fort Wayne metropolitan area.

While IDEM provided field locations, biosolids application dates, methods, and rates data are sparse (Table C-10). Since biosolids application has not occurred in this HU during the last decade, biosolids are not considered a source of RU impairment. Historically, biosolids land application may have contributed to bacteria impairments to waterbodies in this HUC.

F-3.6 St. Joseph River (HUC 04100003 08)

F-3.6.1 Monitoring Data

IDEM collected 5, 6, or 82 samples from 7 sites on the SJR and 2 samples from 1 site on Tiernan Ditch (Table F-6). *E. coli* in the SJR ranged from 5 to 28,000 counts/100 mL with geometric means at the 7 sites ranging from 87 to 1,336 counts/100 mL; 4 sites were on segments that did not attain their RU and 3 sites were on segments that had insufficient data to assess RU attainment.. *E. coli* in Tiernan Ditch was 150 and 170 counts/100 mL; this site was on a segment that had insufficient data to assess RU attainment.

F-3.6.2 Load Duration Curve

LDCs were developed for the two HUC12s with segments impaired for their RUs: Figure F-50 and Figure F-51. *E. coli* data collected by IDEM in 2005 are displayed as loads[60] in Figure F-51. Data collected in 2000 are not displayed in Figure F-50 because loads could not be calculated due to a lack of flow data[61].

One load exceeded the LDC in Figure F-51. To achieve the TMDL (i.e., reduce load to the LDC), the single sample in the moist conditions flow zone would need a reduction of 93 percent.

[60] *E. coli* concentrations from IDEM samples were multiplied by SWAT-simulated flows and converted to appropriate units.
[61] The SWAT model was developed to simulate calendar years 2004 through 2014.

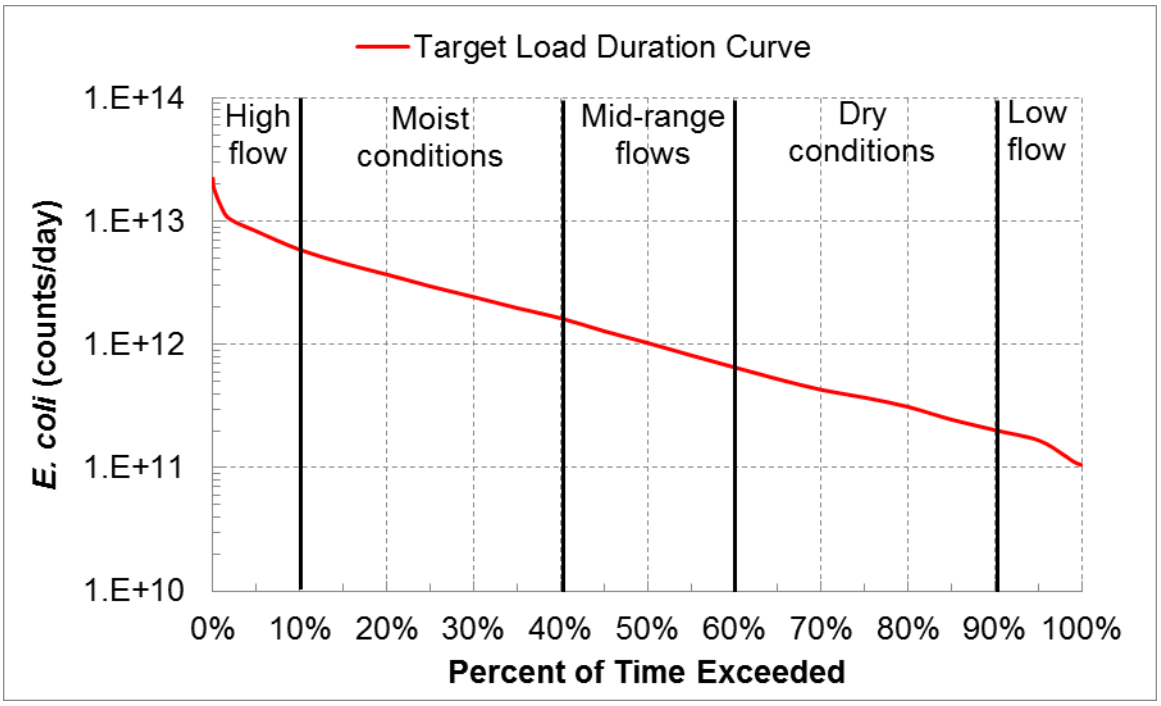


Figure F-50. *E. coli* LDC for the SJR in *Metcalf Ditch-St. Joseph River* (*08 02) just upstream of the confluence of Bear Creek.

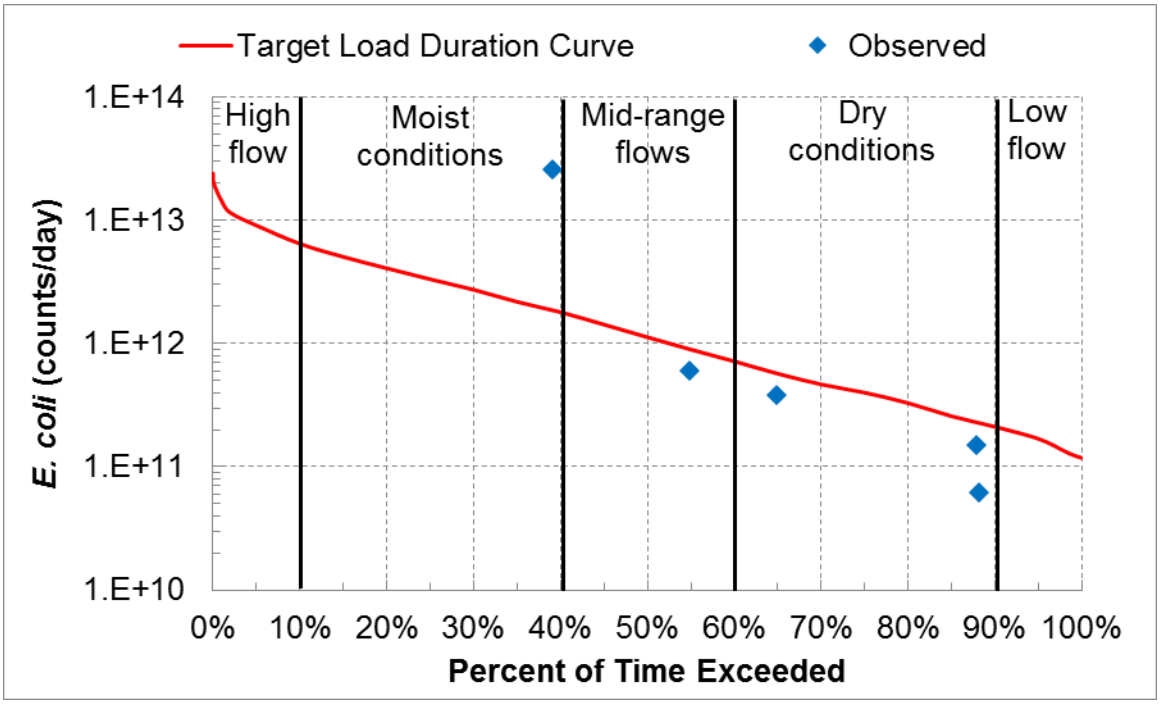


Figure F-51. *E. coli* loads and LDC for the SJR in *Becketts Run-St. Joseph River* (*08 03) at the HU outlet.

F-3.6.3 Sources of Impairment

The potential sources of *E. coli* in this HU are evaluated in the following sections.[62]

F-3.6.3.1 Industrial Facilities with Individual NPDES Permits

Three facilities are covered by individual NPDES permits[63] (see Figures C-3 and C-4 for maps). These facilities are not causing or contributing to the RU impairments on the SJR.

- **Eagle Pilcher Plastic Division** (IN0000574) discharges NCCW to Haifley Ditch. The facility is not permitted to discharge bacteria and NCCW is not expected to be a source of bacteria.
- **DuPont Water Treatment Plant - North End** (IN0060127; 0.1 mgd) is a WTP that discharged to a wetland that is tributary to Keefer Creek. WTPs are not permitted to discharge bacteria, and WTPs are not expected to be sources of bacteria. This facility is no longer operational.
- **Pickle Properties LLC** (IN0032891; 0.036 mgd) discharges is an agricultural property that discharges to Hindman Ditch. The facility is not permitted to discharge bacteria, and thus, is not expected to be a source of bacteria.

F-3.6.3.2 Public Facilities with Individual NPDES Permits

Four facilities are covered by individual NPDES permits[64] (see Figures C-3 and C-4 for maps and Table F-8for DMR data).

- **Deer Track Estates WWTP** (IN0059749; 0.007 mgd) is a sanitary POTW that discharges to an unnamed tributary to J.E. Piquognt Ditch. Effluent volumes were very low (0.001 to 0.020 cfs, average 0.008 cfs) while geometric means of *E. coli* concentrations (1 to 195 counts/100 mL, average 34 counts/100 mL) and loads (253 thousand to 44 million c/d, average 6.2 million c/d) were typically low. Such effluent loads are several orders of magnitude less than the LDC.
- **Fort Wayne Municipal WWTP** (IN0032191; 60 mgd) is a major sanitary WWTP that discharges treated effluent to the Maumee River, which the SJRW is tributary to.

  Fort Wayne is a CSO and SSO community. In the SJRW, six CSO outfalls discharge to the SJR, three SSO outfalls discharge to Salgy Drain, and one SSO outfall discharges to Krunckenberg Ditch. In 2010 through 2014, the six CSO outfalls discharged between 12 and 171 times. CSO volumes ranged from <0.01 to 9.98 million gallons per month. The WWTP's goal is for one CSO per year. Since these outfalls are downstream of the RU impairments on the St. Joseph River, they did not cause or contribute to the RU impairment.
- **Fort Wayne Utilities – Honeysuckle Site** (IN0063061, 0.02 mgd) is a WTP that discharges to the Schwartz-Carnahan Ditch. WTPs are not permitted to discharge bacteria, and WTPs are not expected to be sources of bacteria.
- **Grabill Water Works** (IN0044369; 0.035 mgd) is a WTP that discharges to Witmer Ditch This WTP is not permitted to discharge bacteria, and WTPs are not expected to be sources of bacteria.

F-3.6.3.3 Facilities Covered by General NPDES Permits

Thirteen industrial facilities and one MS4 are covered by general NPDES permits. Portions of the city of Fort Wayne (INR040029) are a regulated as an MS4; such areas exclude the sewersheds draining the

[62] No facilities with general NPDES permits, communities with CSOs or SSOs, or regulated MS4s are in this subwatershed.
[63] The following facility no longer has a permit: Beatrice Cheese Company (IN0000261.
[64] The following two permits were terminated or otherwise no longer have permit coverage: Leo Elementary and High Schools (IN0025267; sanitary) and St. Joseph – Spencerville Regional Sewer District (IN0058411; sanitary).

CSS. The other regaled MS4 is Allen County (INR040131), which excludes Fort Wayne and Fort Wayne's co-permittees.

F-3.6.3.4 On-Site Wastewater Treatment Systems

Much of the lower portion of this HUC10 uses public sewers in Fort Wayne. Rural areas use OWTS to treat commercial and domestic wastewater. Outside of the greater Fort Wayne area, rural areas are composed of crop fields and woodlots. Illicit cross-connections between OWTS and agricultural drain tiles are possible. Grandfathered or illicit off-site discharging OWTS, failing on-lot OWTS, and illicit OWTS connections to drain tiles likely contribute bacteria loads.

F-3.6.3.5 Livestock Operations

Two CFOs are in this subwatershed (see Section 4.2.3 of the main report and Figure C-6 in Appendix C). Concord Veal, with 536 veal calves, drains to Hindman Ditch in the Bear Creek subwatershed (*08 01). Strong Farms LLC, with 2990 beef calves, drains to an unnamed ditch to the SJR (*08 02). Untreated livestock wastewater may not be discharged to surface streams but is a potential source of impairment during larger precipitation events that cause overland flow and runoff.

Within *St. Joseph River* (HUC 04100003 08), SJRWI (2008a) observed livestock during windshield surveys at 164 locations in DeKalb County and 214 locations in Allen County; no livestock with direct access to streams were observed and manure storage was observed at one site in DeKalb County. No additional information about hobby farms and small livestock operations are available. Thus, livestock in Ohio and Indiana may contribute to the nutrient impairment.

F-3.6.3.6 Crop Production

The SJR; Bear Creek; Davis, Nettlehorst, Swartz-Cannahan, Tiernan, and Wilmer ditches; and their tributaries flow through and along row crop fields and woodlots. Manure application to cropland, including tiled cropland, is a potential source of *E. coli* to the impaired segments.

While IDEM provided field locations, biosolids application dates, methods, and rates data are sparse (Table C-10). Since biosolids application has not occurred in this HU during the last decade, biosolids are not considered a source of RU impairment. Historically, biosolids land application may have contributed to bacteria impairments to waterbodies in this HUC.

F-4. References

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